CLEANUP OPTIONS FOR THE STRINGFELLOW ACID PITS SUPERFUND SITE

HEARING

BEFORE THE

SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

ONE HUNDREDTH CONGRESS

SECOND SESSION

SEPTEMBER 10, 1988

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CLEANUP OPTIONS FOR THE STRINGFELLOW ACID PITS SUPERFUND SITE

SATURDAY, SEPTEMBER 10, 1988

House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Natural Resources, Agriculture
Research and Environment,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:02 a.m., in the auditorium at Glen Avon Elementary School, Glen Avon, California, Hon. James H. Scheuer, presiding.

Mr. **Scheuer**. Good morning. I am Congressman Jim Scheuer, Chairman of the Subcommittee on Natural Resources, Agriculture Research, and Environment of the Science, Space and Technology Committee. I am happy to be joined this morning by Congressman George Brown, the distinguished representative of this neighborhood in Washington and one of the ablest and most thoughtful and hard-working members of the Science Committee.

We are also joined by Senator Bob Presley, who also represents the local neighborhood.

And this morning we are going to review once more the Glen Avon Superfund site and we are going to be especially concerned with the progress in cleaning up the Stringfellow hazardous waste site under the federal Superfund program in which George and I, George Brown and I have been intimately involved.

The hearing will particularly focus on the final Feasibility Study which sets out a number of technical options for remediating the Stringfellow site.

It is not our purpose in holding this hearing to influence in any way EPA's cleanup strategy choice. EPA's decision must be based on the record and the public comments which it will be receiving and is currently receiving.

It is rather, to educate ourselves and the American public, on how the Superfund cleanup program is working or likely is not working. For better or for worse, the Stringfellow Superfund site has become a national legacy of toxic waste. And the difficulty of coping with this explosion of toxic waste which our society is producing.

Here we can learn firsthand this morning, about the promise and the problems of cleaning up our toxic inheritance.

Clearly, progress has been painfully slow in coming to Stringfellow. Indeed the history of this site from beginning, almost two decades ago, to the present has been one continuance exemplification of Murphy's Law. And as you all remember, Murphy's Law is that a commandment that we've received on high is, if something can go wrong, it will. And nowhere is this better demonstrated than in the Stringfellow site.

At the last hearing in Glen Avon over five years ago, the then director of EPA's Superfund, estimated that the Feasibility Study could be completed in about a year and that cleanup might be, the cost of cleanup might be in the range of twenty to thirty to forty million. Now, we now know that both those estimates were wildly off the mark.

The final Feasibility Study just released, at a cost of $10,000,000 incidently, the Feasibility Study which costs a third of the lower estimate of the cost of cleanup five years ago; it sets out a variety of cleanup options ranging from roughly half a century to four and a half centuries and the cost ranging from roughly $226,000,000 to a mind-boggling $812,000,000.

It's perfectly conceivable that this cleanup alone could cost a billion dollars, well over one-tenth of the total funding for the national Superfund program.

As a recent Office of Technology Assessment report on Superfund asks, "Are we cleaning up the mess or are we messing up the cleanup?" Certainly none of the options identified in the Feasibility Study come close to meeting this community's hope for a quick, effective and permanent cleanup.

The choice of remedies presented involves difficult, agonizingly difficult, trade-offs. Are there additional alternatives or new technologies that might be considered, or is this the best that we can do? Where do we go from here? These are questions we hope to discuss with our witnesses today.

I am delighted to come back once more to the district of my friend and colleague George Brown, who as I mentioned a few moments ago, is universally regarded as one of the truly thoughtful, creative and responsible, hard-working members of the Congress. His judgment and wisdom are looked to by the entire length and breadth of the Congress of both parties, both houses, on issues like agricultural public policy, environment protection, space exploration and science public policy. And it is a great privilege for me to be here with him today.

At this point I would like to recognize my colleague from California, George Brown, and to turn over the chair to him for the remainder of the hearings.

[The prepared opening statement of Mr. Scheuer follows:]

STATEMENT OF HON. JAMES H. SCHEUER

HEARING ON REMEDIATION STRATEGIES
FOR THE STRINGFELLOW SUPERFUND SITE

BEFORE THE

SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH, AND ENVIRONMENT
OF THE
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
AND THE
CALIFORNIA STATE SENATE COMMITTEE ON
APPROPRIATIONS

GLEN AVON ELEMENTARY SCHOOL
GLEN AVON, CALIFORNIA

SEPTEMBER 10, 1988 9:00 A.M.

THE SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT WILL COME TO ORDER.

TODAY, THE SUBCOMMITTEE RETURNS TO GLEN AVON TO REVIEW THE PROGRESS IN CLEANING UP THE STRINGFELLOW HAZARDOUS WASTE SITE UNDER THE FEDERAL SUPERFUND PROGRAM.

THE HEARING WILL FOCUS IN PARTICULAR ON THE FINDINGS OF THE FINAL FEASIBILITY STUDY WHICH SETS OUT A NUMBER OF TECHNICAL OPTIONS FOR REMEDIATING THE STRINGFELLOW SITE.

It is not the Subcommittee's purpose in holding this hearing to influence EPA's clean-up strategy choice. EPA's decision must be based on its record and the public comments which it is currently receiving.

It is rather, to educate ourselves and the public on how the Superfund clean-up program is -- or is not -- working.

For better or for worse, the Stringfellow Superfund site has become a national symbol of the legacy of toxic waste. Here, we can learn firsthand about the promise and the problems in cleaning up our toxic inheritances.

Clearly, progress has been slow in coming at Stringfellow.

At our last hearing in Glen Avon, over five years ago, the then-Director of EPA's Superfund program estimated that the feasibility study could be completed in about a year and that a clean-up might range in the order of $30 to $40 million.

We now know that both of those estimates were far from the mark.

The final Feasibility Study, just released at a cost of $10 million, sets out a variety of cleanup options ranging from 55 to 448 years and $226 million to a mind-boggling $812 million, one-tenth of the entire Superfund itself.

As a recent Office of Technology Assessment report on Superfund asks, "Are we cleaning up the mess or messing up the cleanup?"

CERTAINLY, NONE OF THE OPTIONS IDENTIFIED IN THE FEASIBILITY STUDY COME CLOSE TO MEETING THE COMMUNITY'S HOPE FOR A QUICK, EFFECTIVE, PERMANENT CLEAN-UP. THE CHOICE OF REMEDIES PRESENTED INVOLVES DIFFICULT TRADE-OFFS.

IS THIS THE BEST THAT WE CAN DO?

ARE THERE ADDITIONAL ALTERNATIVES OR NEW TECHNOLOGIES THAT MIGHT BE CONSIDERED?

WHERE DO WE GO FROM HERE?

THESE ARE THE QUESTIONS THAT WE HOPE TO DISCUSS WITH OUR WITNESSES TODAY.

I AM DELIGHTED TO BE IN THE DISTRICT OF MY GOOD FRIEND AND COLLEAGUE, GEORGE BROWN. GEORGE IS UNIVERSALLY REGARDED AS ONE OF THE MOST EFFECTIVE, HARD-WORKING AND THOUGHTFUL MEMBERS IN CONGRESS.

WE ALL LOOK TO HIS LEADERSHIP ON A WIDE RANGE OF ISSUES, ON AGRICULTURAL POLICY, ENVIRONMENTAL PROTECTION, SPACE EXPLORATION AND SCIENCE POLICY.

I AM PLEASED TO RECOGNIZE MY COLLEAGUE FROM CALIFORNIA, AND TO TURN OVER THE CHAIR TO HIM FOR THE REMAINDER OF THE HEARING.

Mr. **Brown**. Thank you very much, Jim. I think an objective member of the audience listening to you extol my virtues might easily ask, if he is so wise and perceptive and hard working, why has he not got this mess cleaned up before now, and I think that is a very good question. It has been something we have wrestled with for the last sixteen years that we have represented this area.

I want to just say very briefly how much I appreciate your coming out here, Jim. I think the audience should know that we did have a full day in Washington yesterday; we got away about 6:00 last night to come out here, and for Jim this is about 6,000 miles out of his way home because he lives in New York, and he is going to go back to New York when he gets through here. And there are not very many people who will go 6,000 miles out of their way to help a friend and Jim has done that and we appreciate it very much.

Mr. **Scheuer**. George, I can only say that what you say is true but that it tells more about you than it does about me. I would not have missed this opportunity to be here with you.

Mr. **Brown**. Well, we do appreciate it.

We are here today to learn more about how a cleanup decision will be made. As Jim said, EPA Superfund program has been the subject of some rather harsh criticism lately made by such reputable organizations as the Congressional Office of Technology Assessment and the Environmental Defense Fund. Perhaps our knowledgeable witnesses can provide some insight into how we can effectively overcome any shortcomings in this Superfund process as we proceed with this important decision on Stringfellow.

I am going to recognize Senator Presley now and ask him if he has any opening statements, and we are expecting Assemblyman Clute a little bit later on, and we will give him a chance to make a statement, too. Obviously, no hearing is complete unless all the politicians get to make a brief statement.

Senator **Presley**. Well, Congressman Brown, I am going to disappoint you. I do not think I am going to make a statement, I am going to say why do you not just get on with cleaning this thing up and let us not waste the next two or three minutes while I talk.

Mr. **Brown**. You can see why Senator Presley is such a great statesman.

All right, we will proceed with our witness list and I will not elaborate further on the complexity and the fact that this is a joint state and federal project in which both agencies, both governments, have an important part to play.

Our first witness is Mr. Alex Cunningham, who is the chief deputy director of the Toxic Substances Control Division, the Department of Health Services of the State of California. We welcome you here, Mr. Cunningham.

STATEMENT OF ALEX R. CUNNINGHAM, CHIEF DEPUTY DIRECTOR, CALIFORNIA DEPARTMENT OF HEALTH SERVICES

Mr. **Cunningham**. Thank you, Mr. Chairman.

Congressman Brown, Congressman Scheuer, Senator Presley, good morning. My name is Alex Cunningham and I am the Chief Deputy Director of the California Department of Health Services.

In that capacity, I administer the state's toxic waste program, which includes management of state activities on federal Superfund facilities, including Stringfellow. And although the work on this site has been going on for many years, I have only been on the job a little over two years and I have already concluded that when you talk about toxic waste I think Murphy was an optimist.

Although I have provided a full written testimony for the record, I would like to provide a brief history of the site and the state and federal actions to date to remediate the site.

The Stringfellow hazardous waste site was included on the initial Superfund national priority list in 1982 as the State of California's highest priority toxic waste site. A Class I industrial waste disposal site from 1956 to 1972, approximately 34,000,000 gallons of liquid waste were disposed into the site's unlined surface ponds.

During the site's operational and post-operational periods, overflows of the surface ponds occurred during two heavy rains in 1969 and 1978.

An engineering study of the site was conducted and the state's Regional Water Quality Control Board initiated an interim abatement period. During this period surface liquids and DDT contaminated soil were removed from the site. A subsurface plate called a barrier was constructed at the south end of the site. The site was graded, berms leveled and a cap was constructed over the entire surface of the pond area in 1981. Originally they thought this would take care of the site and really this just goes to prove that there is no such thing as a quick fix.

In 1977 the State of California authorized some $3,000,000 to cap the site and now we find ourselves back here eleven years later trying to do it the correct way.

In addition, a surface water diversion system was constructed and a groundwater extraction system installed. Groundwater extracted from the site was transported to BKK and Casmalia disposal facilities. The interim abatement period ended in 1983.

In October 1983, California Department of Health Services declared the site an imminent and substantial endangerment to the public health and the environment.

In 1984 DHS applied to EPA for funding to conduct a Remedial Investigation and Feasibility Study of the site.

In 1984 DHS initiated the Stringfellow Remedial Investigation through a cooperative agreement with EPA.

Science Applications International Corporation, then known as JRB Associates, was selected to conduct the Remedial Investigation. The objective of the RI was to delineate the nature and the extent of contamination resulting from the site, including impacts on air, soils, surface and groundwater.

The RI was completed and a draft report released for public comment in July 1986. The information gathered during the Remedial Investigation was also used in the preparation of the Feasibility Study to evaluate and select remedial alternatives for site cleanup.

The Feasibility Study report and associated treatability studies were carried out on a parallel tract with the Remedial Investigation report. Jan Meyer of my staff and Joe Petrelli from SAIC, who will follow me, will provide details on the development of the Feasibility Study report.

The Feasibility Study was completed and released for the public review on June 30th of this year.

Also, concurrent with the performance of the RI/FS, EHS has implemented a number of interim remedial actions at the site. Some of these remedial actions include design and construction of a pretreatment plant in the midcanyon area to remove metals and organics from groundwater extracted from the site and midcanyon areas.

Secondly, implementation of an ongoing systematic groundwater monitoring system; and third, hookup of approximately 500 residences previously using private wells for domestic water supply to a more permanent non-contaminated community water supply system.

The relationship between EPA and DHS during the RI/FS began with the award of the first Stringfellow cooperative agreement for the conduct of the RI/FS in 1983. The special conditions contained in the cooperative agreement required EPA review and approval of RI/FS tasks prior to work plan approval and implementation.

In addition, any changes in the RI/FS scope of work and any resulting contract amendments also need to be approved by EPA prior to execution. The agencies' joint commitment to the Stringfellow project is evidenced by the Stringfellow action plan developed in 1986. This plan was developed in response to community concerns raised regarding the progress of the cleanup program.

The plan increased state staffing for the Stringfellow project and established a clear framework for review and coordination between the agencies on administrative, technical and community relations issues.

Specifically, we created a special Stringfellow advisory team of thirteen people devoted exclusively to this project and reporting directly to me. No other project in the State of California enjoys that association.

The close relationship between EPA and DHS of joint review and approval has been carried on throughout the Feasibility Study and the remedy selection process. In order to be successful the Stringfellow project has been and will continue to be a joint project with California continuing to exercise lead role responsibility for the site.

Alternatives for the Stringfellow site were first described to the Stringfellow advisory committee in the fall of last year. In the spring of this year EPA and DHS made the decision to separate the decision into two proposed plans.

The first for the community area was released in draft in June of this year.

The second, for the actual site, will be released in just a few months, November of this year.

The Feasibility Study report represents five remedial alternatives which the findings of the RI/FS studies support as the most appropriate alternatives for the site.

Community responses and public input to these various technologies and alternatives have been regularly obtained through the RI/FS process as well as through our monthly Stringfellow advisory committee meetings.

D.H.S. and EPA have worked jointly with the Stringfellow advisory committee and the community technical advisor to prepare the Feasibility Study report. The FS report recommendations are in effect, joint recommendations of the Department of Health Services and EPA.

Following the receipt of very important public comment and a public meeting, DHS and EPA will recommend a specific alternative to the public in a proposed plan. The public comment period for the proposed plan will be thirty days from release of the plan.

Following the public comment period, the proposed plan will be expanded into the Record of Decision or the ROD, which will ultimately be approved jointly by EPA and the Department of Health Services. Approval of the Record of Decision is scheduled for less than a year from now, June of 1989. So I believe finally we see the light at the end of the tunnel.

Let me digress for just a moment and say that one of the most difficult things in cleaning up any site is it often takes a lot longer to do the Remedial Investigation and the Feasibility Study than it does to actually do the initial construction phases.

Financial and personnel commitments by DHS and EPA have been significant. To date, funds allocated by DHS and EPA for the Stringfellow project total $54,000,000. Future funding for implementation of the selected remedial alternative will be provided through a ninety percent federal, ten percent state share.

Because the Stringfellow cleanup alternative involves the restoration of a drinking water aquifer, operation and maintenance of the remedial alternative will be federally funded for the first ten years of operation.

Following the ten-year period, operation and maintenance will then be fully funded by the State of California. DHS anticipates recovering all funds from the Stringfellow responsible parties.

The state Superfund is comprised of funds from the $100,000,000 Hazardous Substance Cleanup Bond Act of 1984. Given the capital cost estimates of the Stringfellow remedial alternatives, the ten percent state share of capital costs for cleanup may range between five and $60,000,000. That is just the state share.

State exposure for operation and maintenance which could continue as long as fifty years beyond the ten-year EPA commitment, will most likely exceed $100,000,000 and could be substantially more. The upper end of the range of state share is more than the remaining unsold bonds. If identified responsible parties do not assume cleanup responsibility for this and other sites currently projected for state and federally funded cleanup, and if DHS assumptions regarding cleanup time lines and costs are correct, all available bond funds will be expended or contractually obligated for specific cleanup actions in early 1989.

In light of the fact that the current funding will almost certainly be insufficient to complete the state share of the costs of cleanup of the Stringfellow site, as well as other sites in the State of California, a major new source of funding for hazardous waste site abatement must be developed.

Currently a new bond measure cannot be considered by the state legislature or the voters of California until the next session and could not become available before 1990. There has been growing dissatisfaction with bonds as a means of providing ongoing funding for the site remediation program.

There continues to be bipartisan support for the cleanup program as well as for providing an alternative means to fund the program in the future. In the meantime, we have sufficient funds to do all planned work for this year and intend to proceed.

In closing, the department recognizes the many competing interests and benefits represented in the decision for the Stringfellow site remedial alternative and the importance of balancing these factors by the decision makers. California remains committed to the expeditious cleanup of the Stringfellow site. We will continue to work earnestly with the community, EPA, and the responsible parties to complete the tasks necessary to achieve this goal.

Thank you.

[The prepared statement of Mr. Cunningham follows:]

TESTIMONY OF
ALEX R. CUNNINGHAM
CHIEF DEPUTY DIRECTOR
CALIFORNIA DEPARTMENT OF HEALTH SERVICES

BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL RESEARCH AND ENVIRONMENT
AND THE CALIFORNIA STATE SENATE COMMITTEE ON APPROPRIATIONS

SEPTEMBER 10, 1988
GLEN AVON, CALIFORNIA

History of the RI/FS

The Stringfellow Hazardous Waste Site (Site) was included on the initial Superfund National Priority List in 1982, as the State of California's highest priority toxic waste site. A Class I industrial waste disposal site from 1956 to 1972, approximately 34 million gallons of liquid wastes were disposed into the Site's unlined surface ponds. During the Site's operational and post-operational periods, overflows of the surface ponds occurred during two heavy rains. An engineering study of the Site was conducted and the State's Regional Water Quality Control Board initiated the Interim Abatement Period. During this period, surface liquids and DDT contaminated soil were removed from the Site, a subsurface clay core barrier was constructed at the south end of the Site, the site was graded, berms leveled and a cap was constructed over the entire surface of the pond area. In addition, a surface water diversion system was constructed and a groundwater extraction system installed. Groundwater extracted from the Site was transported to BKK and Casmalia disposal facilities. The Interim Abatement Period ended in 1983.

In October, 1983, the California Department of Health Services (DHS), declared the Site "an imminent and substantial endangerment to the public health and the environment," citing the following circumstances:

- The Stringfellow site is located five miles northwest of the City of Riverside and one mile north of the community of Glen Avon. The 17 acre site was operated as a hazardous substance disposal facility between 1956 and 1972. 34 million gallons of hazardous substances were disposed at the site.

- Several releases of hazardous substances to Pyrite Creek occurred between 1969 and 1980. The current status of the site poses a diminished but still serious threat of surface discharge and a continuing groundwater pollution problem. An underground plume of contaminated water is flowing toward the Chino II Groundwater Basin and the Community of Glen Avon.

- The State of California and the Environmental Protection Agency have taken several emergency response actions at this site.

- The State must continue to haul contaminated liquids from within the site and from the contaminated groundwater plume downstream of the site to protect the water supply of Glen Avon.

- Groundwater extraction is necessary to prevent buildups of levels of toxic and hazardous waste on-site which could damage existing containment structures and cause a release of hazardous substances into Pyrite Channel which flows through the Glen Avon community. This represents an imminent or substantial endangerment to public health and the environment.

- Section 25358.3 of the Health and Safety Code provides that the Department may contract for any necessary removal or remedial action to remedy or prevent an imminent or substantial endangerment to the public health or the environment caused by such threatened release of hazardous substances, and the such expenditures are exempt from certain contractor procurement procedures.

In 1983, DHS applied to the Environmental Protection Agency (EPA) for funding to conduct a Remedial Investigation (RI) and Feasibility Study (FS) of the Site. In 1984, DHS initiated the Stringfellow RI through a cooperative agreement with EPA. Science Applications International Corporation, then known as JRB Associates, was selected to conduct the RI.

The specific objectives of the RI have been to collect and analyze data to:

- Characterize the nature of the wastes remaining on site
- Characterize the upgradient, on site, and downgradient geology and hydrogeology
- Delineate the nature and extent of groundwater contamination emanating from the Site
- Characterize the transport and migration of waste constituents from on site residual materials into on site and off site groundwater and soils
- Evaluate the integrity of existing on site containment structures

- Evaluate the potential for transport of contaminants in surface water from site runoff

- Evaluate and characterize emissions of contaminants to the atmosphere.

The information gathered during the RI has been used in the FS to evaluate and select remedial alternatives for Site cleanup.

As specified in EPA policy, the RI is completed through a series of Tasks:

(1) Historical Data Synthesis
This Task represents the compilation and summary of all available information about the Site. The information is contained in the report, "Stringfellow RI/FS Task I: Evaluation and Review of Historical Data".

(2) Site Boundary Survey and Map Preparation
Task 2 is a compilation and analysis of information to establish the boundaries of the Site. Site maps and survey data are prepared during the performance of this Task.

(3) Data Collection

All field work and investigations of the RI were conducted under this Task, including; the community well water survey; installation of maid and lower canyon extraction and monitoring wells; comprehensive groundwater survey of existing on site and canyon monitoring wells; lower canyon/community groundwater contamination monitoring; upgradient/on site mapping, drilling and sampling; groundwater flow modeling; downgradient contaminant plume delineation; downgradient surface soil and surface water investigation; and air emissions investigation.

(4) Preliminary Remedial Technologies Summary

This Task is the first transition toward the work of the FS. Remedial technologies with potential applicability for cleanup at the Site were identified and described in the Report "Stringfellow RI/FS Task IV: Preliminary Remedial Technologies." This report was distributed to the Stringfellow Advisory Committee (SAC) and interested public, and was the subject of two community workshops, in an effort to answer questions and determine what the Glen Avon and Orange County communities felt about the various cleanup technologies.

(5) Remedial Investigation Report
Task 5 involved the analysis and synthesis of the data collected through Tasks 1, 2 and 3, development of a health assessment and preparation of the final RI Report, "Stringfellow Site Remedial Investigation Report." Public meetings were held in the Glen Avon and Orange County communities to discuss the findings of the Report and community concerns.

Each of the Tasks are first described in a specific workplan and are approved by DHS and EPA prior to implementation. In addition, the workplans are provided to the SAC members for comment in advance of approval. The results of the work detailed in these workplans is often contained in a Task Report, which is sent to the SAC members and other interested parties.

Since the initiation of the RI, DHS has implemented a number of interim remedial actions at the Site. These actions include:

o Design and construction of a pretreatment plant in the midcanyon area to remove metals and organics from groundwater extracted from the on site and midcanyon areas.

- Implementation of an ongoing, systematic groundwater monitoring program in the lower canyon and Glen Avon community areas.

- Hookup of approximately 500 residences, previously using private wells for domestic water supply, to a permanent, non-contaminated community water supply.

- Research, sampling and analysis of the cause of radioactivity in the groundwater in the Glen Avon area.

- Drilling, sampling and analysis to determine the lateral and vertical extent of the plume of contamination from the Stringfellow Site.

The Relationship Between EPA and DHS During the RI/FS Process

The relationship between EPA and DHS through the RI/FS process has been largely dictated by the provisions and Special Conditions of the Stringfellow Cooperative Agreement and the Stringfellow Action Plan.

The Special Conditions of the Stringfellow Cooperative Agreement are written solely by EPA. In entering into the Cooperative

Agreement, DHS agreed to abide by these provisions. Special Conditions include reporting requirements, procurement standards, funding requirements (State share), litigation and cost recovery requirements, scope of the RI/FS, Health and Safety and Community Relations Plan requirements, EPA approval requirements and review times.

In early 1986, EPA and DHS dissatisfaction with the resources and emphasis placed upon the Stringfellow Site mitigation effort resulted in the negotiation of the Stringfellow Action Plan.
This Action Plan increased staffing for the Stringfellow project to 10 full-time staff, under a full time supervising project manager; increased work with the community by the participation of DHS management in the monthly SAC meetings; and began the State staffing of the Stringfellow Information Center one day per week.

In June, 1987, DHS released the "Stringfellow Hazardous Waste Site Remedial Investigation" Report. The following year, on June 30, 1988, DHS released the "Stringfellow Hazardous Waste Site Feasibility Study."

The Relationship Between DHS and EPA During the Remedial Alternative Decision Making Process

Criteria For Decision-making

The decision making process for the Stringfellow Site remediation is dictated by EPA's RI/FS process. The 1986 Superfund Amendment and Reauthorization Act (SARA) specified that final cleanup solutions must meet certain criteria:

- Protection of Human Health and the Environment
- Attainment of Appropriate, Relevant and Applicable Requirements (ARARs)
- Cost-Effectiveness
- Utilization of Permanent Solutions and Treatment to the Maximum Extent Practicable (MEP)
- Preference for Treatment as a Principle Element or Explanation As to Why Preference is Not Satisfied

In order to meet these criteria, EPA specifies nine areas which must be examined during the FS process:

1. Protection of Human Health and the Environment
2. Attainment of ARARs
3. Short Term Effectiveness
4. Long Term Effectiveness
5. Toxicity, Mobility, Volume Reduction
6. Implementability
7. Cost
8. Support Agency Acceptance
9. Community Acceptance

These nine criteria were incorporated into the Stringfellow FS and are addressed in the FS Report. The public comment period and community meetings to discuss the FS will provide additional information regarding community acceptance.

Process for Decision-making

The decision making process which will determine the remedial alternatives for the Stringfellow Site was first described to the SAC in the fall, 1987. At that time the SAC members requested that EPA and DHS provide their opinion of the most suitable remedial alternative in a cover letter with the release of the FS Report. Subsequent to that request, the SAC members asked that

EPA and DHS not provide the community with the governments' opinion until the completion of the public comment period and the public meetings. DHS and EPA agreed. Consequently, EPA and DHS have discussed the remedial alternatives, but are awaiting additional public comment before reaching any conclusions. The FS Report presents five remedial alternatives which the findings of the RI/FS studies support as the most appropriate for the Site. Community responses and public input to these various technologies and alternatives have been regularly obtained since 1984 during monthly meetings of the SAC and at community meetings conducted by DHS and EPA. Specific elements of these five remedial alternatives have been described and discussed at SAC meetings throughout the past year. During this process, SAC members' ideas and opinions have been incorporated into the remedial alternatives presented in the FS, or examined and not incorporated when the cost, feasibility or technology constraints preclude their use.

DHS and EPA have worked jointly to prepare the FS Report. EPA technical staff attend all meetings regarding the content of the FS Report and have provided comment and input on draft versions of the Report. The FS Report recommendations are, in effect, joint recommendations of the DHS and EPA. Following the receipt of public comment, DHS and EPA will discuss the remedial alternatives and recommend a specific alternative. This alternative will be provided to the public in a Proposed Plan, using the same format as the recently released Community Groundwater Extraction System Proposed Plan. The public comment period for the Proposed Plan will be 30 days. Following the public comment period, the Proposed Plan will be expanded into the Record of Decision (ROD), which will be ultimately be approved by EPA, with concurrence from DHS. Approval of the ROD is scheduled for June 1, 1989.

Current State Financial Commitment to the Project

Financial and personnel commitments by DHS and EPA have been significant. Funds allocated by DHS and EPA for the Stringfellow Project total $54 million:

1.	Treatment Plant O & M:	$ 10.0 million
2.	Cooperative Agreement:	21.5 million
3.	Stringfellow Reserve Account:	16.0 million
4.	State Superfund:	6.5 million
		$ 54.0 million

To date, the following funds have been spent on the projects indicated:

		Spent to Date	Allocation
1.	Interim Abatement Program	$ 4.1 million	$ 4.1 million
2.	Remedial Investigation	6.5 million	9.1 million
3.	Feasibility Study	0.6 million	6.3 million
4.	Treatability Studies	0.7 million	3.4 million
5.	Alternate Water Hookup	2.5 million	3.9 million
6.	Treatment Plant Construction	4.0 million	4.8 million
7.	Early Implementation Actions:	0.4 million	4.6 million

DHS' commitment includes $6.5 million from the State Superfund Account and $16.5 million from the Stringfellow Reserve Account, established by the State Legislature. In addition, DHS returned $3.7 million in approved federal funding to EPA to assist with budget shortfalls due to the delay in the passage of the new Superfund. To maintain project activities during this period, DHS spent $5.1 million during this period. EPA has agreed to allow DHS to apply a portion of this funding toward its future share of cleanup costs. DHS anticipates recovering all funds from the Stringfellow Responsible Parties. Future funding for implementation of the Stringfellow cleanup alternatives will be provided through a 90% Federal, 10% State shared funding. Because the Stringfellow cleanup alternative involves the restoration of a drinking water aquifer, operation and maintenance of the remedial alternative will be funded by the Federal Superfund for the first 10 years of operation. Following the ten year period, operation and maintenance will be fully funded by the State Superfund.

The State Superfund is comprised of funds from the $100 million Hazardous Substance Cleanup Bond Act of 1984. The initial $50 million in bond funds sold to date has been fully encumbered and the cash flow situation is becoming serious as these encumbrances are liquidated. Given the capital cost estimates of the Stringfellow remedial alternatives, the 10% State share of cleanup costs may range between $4.5 and $59.4 million. State exposure for operation and maintenance, which could continue as long as fifty years beyond the ten year EPA commitment, will most likely exceed $100 million and could be substantially more. The upper end of the range of State share is more than the remaining unsold bonds. If identified responsible parties do not assume cleanup responsibility for this and other sites currently projected for State and Federally-funded cleanup and if DHS assumptions regarding cleanup projects timelines and costs are correct, all available bond funds will be expended or contractually obligated for specific cleanup actions by approximately January, 1989. It is estimated that the cost of cleanup of the sites listed in the January, 1988 "Expenditure Plan for the Hazardous Substance Cleanup Bond Act of 1984" will exceed the current bond funds by more than $200 million. In light of the fact that current funding will almost certainly be insufficient to complete the State share of the cost of cleanup of the Stringfellow Site as well as other sites in the State of California, a major new source of funding for hazardous waste site abatement must be developed. Currently, a new bond measure is no longer under consideration by the State Legislature. There has been growing dissatisfaction with bonds and their $3 repayment cost for every $1 spent, as a means of providing ongoing funding for the site remediation program. There is bipartisan support that an alternative means will be found to fund the program in the future. In the meantime, we have sufficient funds to do all planned work for this year and intend to proceed. There continues to be bipartisan support for the cleanup program.

DHS recognizes the many competing interests and values represented in the decision for the Stringfellow Site remedial alternative and the importance of balancing these factors by the decision-makers. DHS appreciates the opportunity to receive and provide information and opinion which this hearing provides.

Mr. BROWN. Thank you very much, Mr. Cunningham.

Mr. CUNNINGHAM. A member of my staff will get into the more technical aspects. Jan Meyer will follow me.

Mr. BROWN. I see she is on the list here.

May I take the prerogative of the Chair and introduce the local supervisor for this area, Miss Melba Dunlap, who has just come in. Melba, welcome to the hearing.

Mr. Scheuer, do you have any questions of Mr. Cunningham?

Mr. SCHEUER. No, no questions at this time.

Mr. BROWN. Bob, Senator Presley?

Senator PRESLEY. No, I do not have any questions really, except, talking about the mind-boggling figures, that $10,000,000 for that study kind of boggles my mind, but I guess—

Mr. SCHEUER. A third of the original estimate of the total cleanup.

Senator PRESLEY. That much money just to do a Feasibility Study, sounds like a lot of money, but you are closer to it than I so you probably have a better response to that than I would.

Mr. CUNNINGHAM. Yes, sir. The sad part of it is, unless you do a very thorough and very detailed Remedial Investigation so that you know exactly the extent of the problem and the types of chemicals and the length of contamination and the direction of the flume, you really cannot come up with a feasible alternative to correct it.

The point that I made earlier in my testimony in 1977 they did a, well for lack of a nicer word, a half-baked alternative, when they thought that capping it would solve the problem and they did not thoroughly do a Remedial Investigation or Feasibility Study eleven years ago and that is why we are still here working on the site.

So you have to spend this money on the front end so that you know exactly what you are dealing with. I know how frustrating it is to the community. If I were a resident here I would be as frustrated as they are. But you have to understand, you cannot do a ten-year job in two years.

Senator PRESLEY. In terms of long-term funding, you indicated that the people in the legislature are getting a little disgusted with bonds, but I guess given that Gann Spending Limit, there is not any alternative, is there? Bonds being outside the spending limit, otherwise I do not know how it could ever be accomplished.

Mr. CUNNINGHAM. That is a very difficult question and one that I think the legislature is going to have to wrestle with, whether or not they want to continue the bond funding. In talking with many members of the legislature and your staff, I am not only talking about bond funds for the hazardous waste program; bond funds in general, it seems we spend three dollars to get a dollar's worth of—

Senator PRESLEY. That is right. But my point is though, given the Gann Spending Limit law, that is on the books, there is not any room to spend any additional money even if the state had it, other than through bonding, which for some reason is outside the Gann limit. That is why everything under the sun, it seems to me anymore, is being financed through bonds, which is not the best way to go, because it is just debt. It is California's national debt.

Mr. CUNNINGHAM. Perhaps society in general is going to have to maybe rethink some of the funding mechanisms.

Senator **Presley**. I think you are right.

Mr. **Cunningham**. I mean society voted many years ago as you know, on the Gann initiative to reduce taxes and now they are saying that maybe they cut a little past the fat and cut through the meat and are now cutting to the bone and they are paying the price. That is a question that is going to be answered at a higher level than mine, Senator.

Senator **Presley**. Thank you.

Mr. **Brown**. The complexity of the Remedial Investigation and the expense of it, you have been commenting on, the fact is that when this site was first opened back in the fifties, I guess it was, we had an inadequate—and completely cursory in hindsight—analysis of the characteristics of the site and potential problems that would be developed as a result of using that site. It has bothered me as I look back to find that the site was a legally permitted site, it met all of the standards for the submission of engineering and other information; the process was wrong.

In other words, it did not go in to all of the characteristics which have now gone into a Remedial Investigation. In looking back, you can say that if we had spent two or three times as much as we spent then, which was probably $50,000, we could have saved $50,000,000. In other words, if we had done a thorough engineering investigation of the granite base to this thing, and observed that it was not impervious but was fractured and that there was a spring coming up through it, all of which should have been observable to a proper investigation, we could have saved a lot of the difficulties that we have had.

You look skeptical, is there any reason why we could not have obtained that information through a proper engineering survey at the time?

Mr. **Cunningham**. Congressman—

Mr. **Brown**. State participated licensing comments.

Mr. **Cunningham**. Well, I understand that.

I guess the comment that comes to mind, and believe me I am not trying to be flippant, is that hindsight is always 20/20, and I think it is not so much the analysis of the site per se; I think that if we roll the clock back twenty-two years to when that site was first permitted, we knew very, very little about the long-term impacts of plastics which were just then really getting into it.

When I was in college in the mid-fifties, I remember they started really coming up with the Saran wrap instead of wax paper and all this kind of thing, and I do not think society, I do not think the technical or the scientific community really could project at that time the long-term detrimental effects of a lot of the products that society is demanding. I mean society is the one that wants these niceties of life; the VCRs, the microwave ovens, the Saran wrap, all these goodies and they do not realize or they certainly did not realize at that time, that there were some down-sides and I think if you just roll the clock back ten or twelve years, we could not even measure contamination in parts per billion; it was parts per million was the best that could be done, and when you took readings at parts per million, you saw a zero and you said, well gee, it must be okay. Then all of a sudden when you come with the ability to measure in parts per billion, another five, six, ten years down the line, and you get 200 parts per billion, people say, oh my God, that is terrible. And yet that is two-tenths of a part per million which was the closest you could measure years before.

As far as geology is concerned, and the bedrock, bottom of the site, having been in the emergency services business, as my friend Senator Presley knows, earthquakes do strange things and while the site may have indeed been considered by the best geologic minds in those days as an impermeable site, earthquakes can change the characteristics of a bedrock foundation and I guess we live and learn.

That is a long answer to a—

Mr. SCHEUER. Just to footnote what you are saying, what you are saying, you are absolutely on target. One of the things that has changed in the last ten years, is the explosion of knowledge that we have obtained in how to measure things. As you said, a decade ago, it was parts per million. Then we got parts per billion, then we got parts per trillion, and now we are into parts per quadrillion. We can measure the presence of a fraction of a drop of dioxin in an Olympic swimming pool. We could not have begun to do that ten years ago.

So at least one of the encouraging aspects of this whole, awful problem, if you can be encouraged, is that at least we can quantify the problem with truly, astonishingly, accurate and fine-tuned measurements. We were in no position to do that ten years ago.

Mr. CUNNINGHAM. Yes, sir. And back in the fifties, were any of us in business at that time, we are going to look for the cheapest alternative, and I believe that communities, excuse me, I believe that industries back in the fifties, honestly did not know the long-term environmental damages that would be caused by taking something to a landfill. As Congressman Brown pointed, it was permitted by the state and federal agencies. And I think now we are seeing a commitment on the part of industry to change their processes.

For example, in California every year there are 1.4 million tons of hazardous waste that is going offsite for disposal. Three years ago, fourteen percent of that was being recycled by industry. Just three years ago, fourteen percent. Today it is thirty-three percent. We are very much in the forefront in California and I know this is getting off the cleanup phase, but into the alternative technologies, we are pushing vigorously for product substitution, for recycling and things of this nature. That is part of the problem, but today we are here to talk about cleanup. We have to correct our past mistakes.

Mr. SCHEUER. There are some lessons to be learned, as you pointed out. In the past, we in government perhaps, have relied too much on confrontation. Legal confrontation between the government and industry; finger-pointing as to who was wrong, who the bad guys are.

I think now we have come to the conclusion that there are a lot of decent people out there in industry; there is a lot of genius out there in industry.

It was the genius in the chemical industry, after all, that produced these very products that you are talking about, the Saran wrap, and this incredible proliferation of packaging, that has caused this problem. And George and I and many others have come to think that rather than just establishing confrontation between industry and the regulators and the executive branch, and industry and the legislators, perhaps we all ought to get together and pool our knowledge and work in a constructive way, harnessing all that genius that produced the products that now are giving us the problems. But as you very well said, produced the products in response to a demand out there for all these conveniences; better living through chemistry, the word was.

Mr. **Cunningham**. Yes, sir.

Mr. **Scheuer**. And I think in the future you are going to find that Congress is a lot more amenable to sitting down in a quiet, non-confrontational way with industry reps and saying, look, how do we harness all your talent to solve this problem? Because if we do not harness your technical talent to produce an answer that you can live with, you are going to harness your legal talent and hire $300-an-hour Wall Street lawyers to stop everything that we are doing under our constitutional system, which they can do very well; and it has happened over many years.

We cannot legislate and get new rules and regs in a final form in less than a decade. Such is the legal process that provides industry with all kinds of motion practice to delay and deter and push downstream any possible effect of legislation.

So I think you are pointing to the wave of the future, of creating some kind of a partnership between our scientific establishment, both in industry and in the universities, and the regulators, and the legislators, and business leadership, and coming up with solutions that will work, and getting on with it.

Mr. **Cunningham**. Yes, sir. Absolutely, you are right on. There is a lot of that being done between government and industry right now, but I do not think it is really being brought to the public's attention because it is not sensational and therefore we do not see it in the newspapers yet.

But do not let me try to mislead anybody; there is not enough being done, there needs to be more so that we look for correcting the problems on the front end instead of on the tail end like we are doing with all of our cleanups in the state.

Mr. **Scheuer**. You have got it.

Mr. **Brown**. Mr. Cunningham, we got started on this line of discussion here when I suggested we should have spent a little bit more money in the original investigation of this site before we permitted it and you went off on a long story about how much better the science is today, and we could not anticipate all these things, which is all very true. But that site was originally permitted for the most toxic of chemicals; heavy metals and so forth. No problem about detection, we knew we were putting the most hazardous kind of chemicals that society generated in that site.

And the whole question of the fact that methods of protecting toxicity today has improved, is somewhat irrelevant in my opinion. Do not take offense at that, I am just making that as a statement.

You also jumped to the defense of the engineering that led to it. The fact is, they did not drill enough holes to determine whether that was a solid or a fractured space and no engineer could have jumped to the conclusion that it was impervious based on the amount of data that was available. There is no evidence that earthquakes changed that.

Now, I do not know why you are being defensive of an action that was taken thirty years ago. You did not take the action and you do not have to worry about it.

Mr. Cunningham. I did not mean to appear defensive. I do not know what the answers are on that, Congressman. You are right, I was not here, I was not even in California in those times. But whether they did or did not, through an adequate investigation of the site, that could probably—that statement could probably be made by many of the sites, many of the disposal sites.

Mr. Brown. All I am trying to say is in light of all this vast new knowledge that we have today, we ought to be a little smarter and do a better job than we have in the past.

I want to ask you just one more question and then I am going to excuse you and take the next panel.

This is a good time to introduce our colleague Senator Clute, who has just come in and shares our common concern for the action that has taken place on this site.

There has been from the beginning of our investigation into this, a discussion of technology as being the most effective. I am not one-hundred percent satisfied that the technology shown in the Feasibility Study encompassed the universe of technologies that could be used economically to clean up this site.

The question I have to you is, would the state be willing to consider additional technologies that might show promise for a more permanent and cost-effective treatment despite the fact that they are not thoroughly considered in the present Feasibility Study, if it should become clear that they might do a better job?

Mr. Cunningham. Congressman, I think the state—and I think I can safely speak for EPA, is always willing to listen and look for additional alternatives. We have explored some eighty alternatives to date and Miss Meyers' presentation will get into some of those, the rationale for choosing the ones we did. I guess the question that I would have in my mind about that, is whether the community is going to be willing to let us go back to the drawing board, so to speak, to look at some other alternatives or if the alternatives that have been proposed, and certainly we are always looking for a way to do something cheaper, because if it is not RP dollars, it could be taxpayers' dollars. We certainly do not want to do anything that is going to continue to pose threats to the community. And I guess what I would like to hear from our public hearing, or perhaps at this hearing today, how the community would feel about looking at other alternatives, but we would certainly be willing to look at some other alternatives, yes, sir.

Mr. Brown. Well, you have got your public hearing scheduled for thirty days?

Mr. Cunningham. September 20th.

Mr. Brown. September 20th, well that is much closer. You will get plenty of input from the public on that.

Thank you very much for your contribution.

I am going to let you go, and Jan and, I think, you and Beth Jines and Joe Petrelli are supposed to be the next panel.

Ms. Meyer. Yes.

Mr. **Cunningham**. Yes, sir. They are going to—

Mr. **Brown**. Can they get along without you?

Mr. **Cunningham**. I hope so. If they cannot, I have not done a good job.

Mr. **Brown**. Move along and leave the room for us.

All right, this second panel composed of Jan Meyer and Beth Jines, who are from the Toxic Substances Control Division of the Department of Health Services, which Mr. Cunningham is part of, and Joe Petrelli, is that you Joe?

Mr. **Petrilli**. That is me.

Mr. **Brown**. You are replacing Dr. Shokes?

Mr. **Petrilli**. Right.

Mr. **Brown**. And you are from SAIC and you are going to explain what a great job you have done on this study.

Okay Jan, do you want to start? You are listed first on my sheet here.

STATEMENT OF JAN MEYER AND BETH JINES, STRINGFELLOW PROJECT TOXIC SUBSTANCES CONTROL DIVISION, CALIFORNIA DEPARTMENT OF HEALTH SERVICES

Ms. **Meyer**. Good morning, committee members.

I have already been introduced by Mr. Brown. This is Beth Jines on my left. She is the technical lead for the Stringfellow project for the state Department of Health Services. On my right is Mr. Joe Petrelli. He is project manager for SAIC, filling in for Dr. Robert Shokes today.

We are here today to present a brief history of the screening and evaluation process utilized in the Stringfellow Feasibility Study process.

The process of screening technologies for application to the Stringfellow cleanup has been ongoing since the start of the Remedial Investigation in 1984. Essentially, there have been three phases of screening and evaluation.

The first effort to identify remedial technologies was undertaken by SAIC, Science Applications International Corporation, under contract to the Department, as part of the Task IV of the Remedial Investigation. The Task IV report, entitled Preliminary Remedial Technologies, was released in 1985 and included a list of available technologies that covered a wide range of treatment options for both groundwater and soil and waste contaminants. These technologies were then screened using the site-specific data available at that time.

Attachments 1 through 3 of my written testimony list the technologies evaluated; those which were eliminated and those which survived the screening process. In essence, the Task IV report served as the first link between the Remedial Investigation and the Feasibility Study efforts.

The second phase effort produced a draft interim report on development and screening of remedial technologies and alternatives and was released in July 1985. This report was a working document designed to introduce the process by which the cleanup technologies would be screened and then combined into remedial alternatives for the Stringfellow site.

The process by which candidate remedial technologies and corresponding data needs were initially identified for this report involve three steps.

The first step was to identify the control response categories relevant to the contamination present at the site. Control response categories identified were: groundwater protection; surface water protection; air pollution prevention; waste and contaminated sewer control; and leachate and contaminated water control.

The second step was to identify applicable technologies within each response category. Applicable technologies are shown on Attachment 4 of my testimony.

In the third step, approximately eighty-six identified technologies for the upgradient on-site and downgradient areas of this site, were evaluated according to the following factors. Compatibility with waste and leachate characteristics. Compatibility with spatial constraints at the site. Compatibility with availability of offsite facilities, utilities, et cetera. Compatibility with subsurface hydrogeologic conditions. Equipment availability and the size scale necessary to address the problems of Stringfellow. The state of development of the technology under evaluation and reliability of the technology due to inherent construction, operation and/or maintenance problems.

As a result of this initial screening, over fifty percent of the original candidate technologies were either eliminated from further consideration or were judged to have uncertain applicability.

The findings in the July interim report were carried on into the Task XI/XII report, released in May 1986. The purpose of this report was to combine the remedial technologies which survived the July interim evaluation and to identify remedial alternatives which would, one, prevent or significantly minimize migration of contaminants from the site, and two, prevent or minimize impacts from contaminants which have already migrated from the site.

While the July interim report screen technologies on the more broad basis of applicability to the Stringfellow site, the Task XI/XII report began the more specific job of screening for technical feasibility, public health and environmental impacts and cost effectiveness.

The remedial technologies remaining from the July interim report were narrowed down to about thirty candidate remedial technologies and costs were estimated for each. These are shown on Table 2 of my testimony.

In addition, the Task XI/XII report was the first to recommend mitigation of the downgradient community groundwater plan as a common component of all remedial alternatives under consideration.

As a result of the evaluation efforts, the Task XI/XII report identified the following general remedial alternatives for the site. Onsite leachate management only; dewatering only; dewatering excavation treatment by neutralization and RCRA cell construction; dewatering excavation, treatment by incineration and chemical stabilization, and redisposal on site.

The work plan for Task XI/XII and the resulting Task XI/XII report remain available for public review and comment. Following the public meeting in September 1986, comments were received from Congressman Brown, the community technical advisor (Environ) and community members. The Office of Technology Assessment was also contacted to obtain a listing of emerging technologies.

In addition, SAIC staff and Stringfellow project staff members attended a technologies workshop sponsored by Concerned Neighbors in Action.

The TASK IV and XI/XII reports, although not required by CERCLA, utilized the screening process described by EPA protocol.

The third and final phase of the Feasibility Study process generated the draft Feasibility Study report released last June. This report is a culmination of all previously discussed reports.

Between the release of the XI and XII report and the Task XIV Feasibility Study report, the Superfund Amendments and Reauthorization Act, or SARA, was passed. SARA modified the criteria used for evaluation of remedial alternatives. Specifically, SARA requires that the remedial alternatives be evaluated using the following criteria:

One, protection of human health and the environment.

Two, attainment of applicable or relevant and appropriate requirements.

Three, short-term effectiveness.

Four, long-term effectiveness.

Five, reduction of toxicity, mobility, and volume of hazardous materials.

Six, implementability.

Seven, cost.

Eight, support agency acceptance, and

Nine, community acceptance.

A detailed description of these criteria will be provided by Jeff Zelikson of the USEPA.

As a result of SARA, the draft Feasibility Study report provides a more detailed evaluation of the alternatives than is found in the Task XI and XII report.

Table 3 of my testimony provides a list of the remedial alternatives that survived the Phase 1 and 2 screening processes.

The remedial alternatives recommended in the XI/XII report were carried into the FS report and modified to reflect the new site information and data.

Neutralization and biological treatment were deleted while insitu flushing, soil gas extraction, mechanical evaporation and insitu soil washing were added. Six remedial alternatives resulted which are presented in the FS report and which will be expanded upon by Mr. Petrilli.

The first is no action which is required under CERCLA.

Two, natural flushing of on-site area and downgradient plume management.

Three, on-site dewatering, extraction and treatment of on-site leachate and downgradient plume management.

Four-A, on-site dewatering, extraction and treatment of on-site leachate, soil gas extraction followed by in-situ flushing and downgradient plume management.

Four-B, on-site dewatering, extraction and treatment of on- site leachate, soil gas extraction, selective soil excavation and treatment followed by in-situ flushing and downgradient plume management.

And lastly, five, excavation and treatment of all on-site diggable soil.

These alternatives and their associated costs will be described in detail by Mr. Petrilli of SAIC.

That concludes our presentation.

[The prepared statement of Ms. Meyer and Ms. Jines follows:]

TESTIMONY OF
JAN MEYER AND BETH JINES
STRINGFELLOW PROJECT
TOXIC SUBSTANCES CONTROL DIVISION
CALIFORNIA DEPARTMENT OF HEALTH SERVICES

BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL RESEARCH,
AND ENVIRONMENT
AND THE CALIFORNIA STATE SENATE COMMITTEE ON APPROPRIATIONS

SEPTEMBER 10, 1988
GLEN AVON, CALIFORNIA

Technologies Initially Outlined for Consideration

Phase I - Development of Alternatives

The process of screening technologies for applicability to cleanup of the Stringfellow Hazardous Waste Site has been ongoing since the start of the Remedial Investigation (RI) and Feasibility Study (FS), in 1983. Three reports on the technologies being considered for application at the Stringfellow Hazardous Waste Site preceded the June, 1988 Draft Feasibility Study Report. Following the release of two of these reports, public meetings were held in Riverside and Orange Counties to discuss the report contents and the technologies described. Public meetings have been scheduled in Riverside and Orange Counties to discuss the findings of the FS Report. The following is a brief description of the purpose and content of each of these reports which document the technology screening and remedial alternative evaluation process.

Preliminary Treatment Technologies Report

The first technology screening report on the Stringfellow Site was released in April, 1985. The draft report, "Task IV: Preliminary Remedial Technologies," served as the first link between the RI and FS and included a preliminary list of available technologies for direct treatment of wastes at Stringfellow. The list, Attachment 1, included different technologies such as cement based pozzolanics, incineration, grout curtains, biodegradation, flushing, and reduction. This listing was then screened to remove those technologies which were not applicable to the specific type of contamination found at the Stringfellow Site. The screened technologies are found in Attachment 2. For example, cement based pozzolanics are not recommended treatment alternatives for organic solvents or oils, which comprise a portion of the Stringfellow waste materials. A list of treatment alternatives for further study was developed from the initial list of alternatives and is shown in Attachment 3. This study and results were discussed at a monthly Stringfellow Advisory Committee meeting.

The workplan for this task, as well as the report itself, were both made available for public review and comment.

Attachment 1

PRELIMINARY LIST OF DIRECT TREATMENT ALTERNATIVES

Stabilization/Solidification

Cement based
Pozzolanics
Thermoplastic
Organic polymer
Self-cementing
Glassification
Bulking
Surface encapsulation

Incineration

Liquid injection
Rotary kilns
Fluidized beds
Multiple hearths
High temperature fluid wall
Plasma reactor
Molten Salt
Cement kiln
Pyrolysis/starved combustion
Wet air oxidation

In-Situ Treatment

Hydrolysis
Oxidation
Reduction
Soil aeration
Solvent flushing (solution mining)
Neutralization
Polymerization
Sulfide precipitation
Bioreclamation
Permeable treatment beds
Chemical dechlorination
Solvent extraction
Composting

Grouting

Particulate
Chemical

Chemical

Carbon adsorption
Ion exchange
Cellulose xanthate complexing
Sodium borohydride reduction
Surfactant complexing

Biological

Aerobic biodegradation
Anaerobic/aerobic cycling
Anaerobic biodegradation
Adapted microbial cultures
Bioreclamation of soils

Others

Ground water pumping
Aquifer recharge
Land spreading/land farming
Solids separation
Resource recovery
Revegetation

Attachment 2

NON-APPLICABLE TREATMENT ALTERNATIVES

Stabilization/Solidification

Cement-based	not for organic solvents or oils
Pozzolanics	not for organic solvents or oils
Thermoplastic	not for high concentrations of organic solvents
Organic	not for organics, oils, metal hydroxides, strong oxidizers
Self-Cementing	only for calcium sulfate and calcium sulfide
Surface encapsulation	only small volumes of highly toxic waste
Glassification	only for heavy metals, sulfates and halides
Bulking	not for waste with high water content

Incineration

Rotary kiln	not for wastes with high inorganic content
Liquid injection	not for high moisture or high inorganic content
Molten salt	organics only
Cement kiln	liquids only
Pyrolysis/starved combustion	only for purely organic wastes
Wet air oxidation	not for inorganics

In-Situ Treatment

Hydrolysis	extremely waste specific
Reduction	extremely waste specific
Soil Aeration	only volatiles
Polymerization	not for complex mixtures
Sulfide precipitation	only heavy metals
Bioreclamation	only for biodegradable wastes
Permeable treatment beds	only for certain metal cations
Chemical dechlorination	only for highly chlorinated hydrocarbons
Solvent extraction	not for complicated waste mixtures

Attachment 3

TREATMENT ALTERNATIVES REQUIRING FURTHER STUDY

Incineration

Fluidized beds
Multiples health
High temperature fluid wall
Plasma reactor

In-Situ

Oxidation
Solvent flushing (solution mining)
Neutralization
Composting

Grouting

Particulate
Chemical

Other

Ground water pumping
Aquifer recharge
Land spreading/land farming
Solids separation
Resource recovery
Revegetation

Chemical

Carbon adsorption
Ion exchange
Cellulose xanthate complexing
Sodium borohydride reduction
Surfactant complexing

Biological

Aerobic biodegradation
Anaerobid/aerobic cycling
Anaerobic biodegradation
Adapted microbial cultures
Bioreclamation of soils

Draft Interim Report on Development and Screening of Remedial Technologies and Alternatives

Phase II - Screening of Alternatives

In July, 1985, the California Department of Health Services (DHS) published the "Draft Interim Report on Development and Screening of Remedial Technologies and Alternatives". This Report was a working document designed to introduce the process by which the cleanup technologies would be screened and then combined into remedial alternatives for the Stringfellow Site. The 1985 Report gave a broad overview of the cleanup problems presented by the Stringfellow Site and the types of technologies which could be used to address these problems. Because community acceptance is an integral part of any cleanup scenario, DHS felt this Report and the May, 1986 "Combined Task XI/XII Development and Initial Screening of Alternatives Draft Report" (XI/XII Report) to be essential. Although these Reports are not required as elements of the Environmental Protection Agency (EPA) RI/FS process, DHS and EPA felt that the information the Reports provide and the opportunity for community input into the selection process justified their production.

The intent of the July, 1985 Report was to provide the public with the information developed to date in the Remedial Investigation (RI) and the Feasibility Study (FS). The Report described the progress made in characterizing the contamination at the Stringfellow Site and the technologies being examined for mitigation of that contamination. The Interim Report characterized the Site in terms of on site and downgradient contamination and described the applicable State and Federal environmental standards and guidelines, including the California Department of Health Action Levels, Federal Safe Drinking Water Act Maximum Contaminant Levels, Clean Water Act Criteria for Drinking Water, Safe Drinking Water Act Health Advisories and regulations and standards of the following agencies:

- California Regional Water Quality Control Board - Santa Ana Region
- South Coast Air Quality Management District
- Santa Ana Watershed Project Authority
- Chino Basin Municipal Water District
- Department of Transportation

The process by which candidate remedial technologies and corresponding data needs were initially identified involved three steps. The first step was to identify existing and potential problems at the Site. Five categories of control responses were

Attachment 4

Table 6-1. Candidate Remedial Technologies

WASTE AND CONTAMINATED SOIL CONTROL

Removal and Off-Site Disposal

Removal and On-Site Disposal

Thermal Destruction

- pyrolysis
- rotary kiln incineration
- fluidized bed incineration
- multiple hearth incineration
- liquid injection incineration

Solidification/Stabilization/Fixation

- cement-based
- pozzolanics
- thermoplastic
- organic polymer
- solidification materials
- surface encapsulation
- vitrification

Other Treatments for In Situ and Excavated Wastes

- reduction
- oxidation
- polymerization

- sulfide precipitation
- neutralization
- water/solvent flushing, collection, and treatment
- biological degradation

LEACHATE AND CONTAMINATED WATER CONTROL

Physical Treatment

- flow equalization
- flocculation
- sedimentation
- activated carbon
- filtration

- ion exchange
- reverse osmosis
- oil/water separator
- steam distillation
- air stripping
- steam stripping
- dissolved air flotation

Chemical Treatment

- precipitation
- neutralization
- oxidation
- reduction
- ultraviolet/ozone

Biological Treatment

- PACT™
- activated sludge
- aerated lagoons
- trickling filters
- rotating biological discs

Disposal (with pretreatment as necessary)

- discharge to publically-owned treatment works (POTW)
- discharge to surface waters
- off-site reinjection
- disposal to Class I or Class II-1 disposal site
- reuse on-site for process purposes
- solar evaporation
- reuse off-site as industrial or agricultural water

GROUNDWATER PROTECTION

Capping

- clay
- asphalt
- synthetic membranes
- concrete
- fly ash mixtures
- soil cement/clay mixtures
- multilayered systems

Containment Barriers

- soil-bentonite slurry walls
- cement-bentonite slurry walls
- diaphragm walls
- vibrating beam slurry walls
- grout curtains
- steel sheet piling
- grout bottom sealing
- clay liners
- synthetic liners
- multilayered liners

Groundwater Diversion and Collection

- injection/extraction wells (recharge)
- extraction wells
- subsurface drains
- hydrofracturing
- peripheral tunnel (adit)

SURFACE WATER PROTECTION

Grading
Revegetation
Run-on Control
Erosion and Run-off Control

AIR POLLUTION PREVENTION

Dust Control

- polymer sprays
- water sprays
- gravel cover
- windscreens
- windbreaks
- revegetation

Vapor Control

- chemical stabilization of waste
- capping
- waste removal
- collection and treatment

identified as potentially relevant to the Stringfellow Site:

- Groundwater Protection
- Surface Water Protection
- Air Pollution Prevention
- Waste and Contaminated Soil Control
- Leachate and Contaminated Water Control.

The second step was to identify potentially applicable remedial technologies within each of these response categories (Attachment 4). In the third step, the range of information and data generally needed to evaluate remedial technologies was identified. Data obtained from the RI and concurrent FS investigations helped to identify factors and conditions that could limit or promote the use of specific remedial technologies at the Stringfellow Site. The technologies were evaluated according to the following factors:

- Implementability at the Stringfellow Site
- Technological Status (state of development)
- Environmental Concerns
- Reliability
- Siting Considerations

Applicability of a specific technology to the Stringfellow Site was considered for each of the three general site areas:

- Upgradient of the waste pile
- On site within the boundaries of the waste pile
- Downgradient from the waste pile

The technology screening procedure began with an evaluation of the site characterization data then available and the general engineering knowledge of remedial actions. Areas with inadequate existing data were identified so that additional information could be gathered through subsequent RI activities, treatability studies and/or literature searches. Eighty-six candidate remedial technologies were evaluated on the basis of the following technological factors:

- Compatibility with waste and leachate characteristics and site conditions.

- Compatibility with spatial constraints at the Stringfellow Site.

- Compatibility with the availability of off-site facilities, utilities, etc.

- Compatibility with subsurface hydrogeologic conditions at the Site.
- Equipment availability in a size/scale necessary for the Stringfellow Site.
- State of development of the technology.
- Reliability of technology due to inherent construction, operation, and/or maintenance problems.

As a result of this initial screening, over 50 percent of the original candidate technologies were either eliminated from further consideration or were judged to have uncertain applicability.

Again, the workplan and the Report itself were made available for public review and comment. A public workshop was also held in August, 1985 to receive public comment.

Draft Task XI/XII Development and Initial Screening of Alternatives

The Task XI/XII Report, on the development and screening of alternatives was released in May of 1986 and was based upon data derived from the ongoing RI/FS and the previous July Interim Report. The purpose of the Task XI/XII Report was to combine surviving technologies into remedial alternatives which would:

- prevent or significantly minimize migration of contamination from the Site

- prevent or minimize impacts from contaminants which have already migrated from the Site

While the July, 1985 Report described response actions and screened technologies on the more broad basis of applicability to the Stringfellow Site, this Report began the more specific job of screening for technical feasibility, public health and environmental impacts, and cost effectiveness. The remedial technologies remaining from the July, 1985 Report were narrowed down to about 30 candidate remedial technologies and costs were estimated for each (Table 2). In addition, the Task XI/XII Report was the first to recommend mitigation of the downgradient (community) groundwater plume by using extraction well barriers and management of the contaminated groundwater as a common component to all remedial alternatives, except the "no action" alternative.

As a result of the evaluation efforts, the Task XI/XII identified the following remedial alternatives as being feasible for

Table 2

Cost Summary of Various Remedial Actions

Subsection No.	Process	Estimated Capital Cost, $(1)	Estimated O&M Cost $/YR	Basis for Cost Estimating
4.2.2	Adit/gallery system	22,100,000	250,000	9,000 ft. of tunnel and 140,000 ft. of drainholes. Does not include management of extracted contaminated wat[illegible].
4.2.3	Upgradient/on-site extraction wells	7,700,000	1,620,000	Assume 65 clean groundwater interception wells and 35 leachate extraction wells, average 150 ft. deep. Does not include management of extracted contaminated water. Includes collection piping.
4.2.4	Improved surface water management	645,000	10,000	Involves approximately 5,000 ft. of new flood control channel addition to existing.
4.2.5	Recapping on-site area	2,600,000	73,000	$130,000/acre for multi-layer cap capital cost.
4.2.6	Excavation of digable on-site contaminated soil	16,000,000	---	Based upon 908,000 cu. yds. of material. Does not include cost of treating contaminated water removed during excavation.
4.2.7	Transport and disposal of excavated material to off-site RCRA Permitted facility	241,000,000	---	Casmalia Resources, Casmalia, CA
		177,000,000	---	I.T. - Imperial Valley, Westmoreland, CA
		213,000,000	---	I.T. - Benicia, CA
		165,000,000	---	U.S. Ecology, Beatty, NV
4.2.8	On-site neutralization of excavated material	7,230,000	---	Costs based on 6 year period to treat a total of 1,180,000 cubic yards. Calculates out to approx. $6.00/cubic yard.
4.2.9	On-site incineration of excavated material	207,090,000	---	Based upon estimated cost of $175.00/cubic yard of contaminated material. Based on 1.18 million cubic yds.
4.2.10	On-site fixation of excavated material	122,600,000	---	$104/cubic yard of contaminated soil. Based on 1.18 million cubic yds.
4.2.11	Redisposal of excavated, treated material to on-site RCRA type facility	33,100,000	180,000	Twelve cells of 100,000 cubic yard capacity each with double liner.
4.2.12	Redisposal of excavated treated material to on-site Class II type facility	23,653,000	180,000	Twelve cells of 100,000 cubic yard capacity each with double liner.
4.2.13	Downgradient extraction well barrier in mid-canyon	0	159,000	System assumed existing in mid-canyon.

Subsection No.	Process	Estimated Capital Cost, $ (1)	Estimated O&M Cost $/YR	Basis for Cost Estimating	
4.2.14	Downgradient extraction well barrier in lower canyon and community	271,000	107,000	Effluent managed near extraction well barrier.	
		439,000	120,000	Effluent pumped to mid-canyon treatment plant.	
4.2.15	Downgradient reinjection wells	286,000	34,000	Capital cost assumes that treatment takes place in mid-canyon and treated water is piped south o Highway 60.	
4.2.16	Flow equalization for on-site or mid-canyon extracted waters	220,000	5,000	10 gpm flow rate (5 day storage capacity)	
		410,000	5,000	20 gpm flow rate (5 day storage capacity)	
		820,000	10,000	50 gpm flow rate (5 day storage capacity)	
		1,100,000	15,000	100 gpm flow rate (5 day storage capacity)	
	Flow equalization for lower canyon or community extracted waters	135,000	5,000	10 gpm flow rate (5 day storage capacity)	
		250,000	5,000	20 gpm flow rate (5 day storage capacity)	
		490,000	10,000	50 gpm flow rate (5 day storage capacity)	
		660,000	15,000	100 gpm flow rate (5 day storage capacity)	
4.2.17	Precipitation for metal removal using lime	830,000	1,350,000	10 gpm flow rate	
		920,000	1,600,000	20 gpm flow rate	
		1,300,000	2,110,000	50 gpm flow rate	
		1,770,000	2,790,000	100 gpm flow rate	
4.2.18	Biological treatment using bio-contactors (RBC)	250,000	73,000	10 gpm flow rate	
		430,000	120,000	20 gpm flow rate	
		800,000	200,000	50 gpm flow rate	
		1,100,000	300,000	100 gpm flow rate	
4.2.19	Air stripping for mid-canyon extracted groundwater	20,000	6,000	10 gpm flow rate	Air emission controls, if needed, not included in costs.
		40,000	11,000	20 gpm flow rate	
		95,000	27,000	50 gpm flow rate	
		190,000	53,000	100 gpm flow rate	
	Air stripping for lower canyon and community extracted groundwater	17,000	5,000	10 gpm flow rate	
		35,000	9,000	20 gpm flow rate	
		85,000	23,000	50 gpm flow rate	
		170,000	46,000	100 gpm flow rate	
4.2.20	Activated carbon contact beds for on-site leachate	400,000	1,260,000	10 gpm flow rate	Assumes carbon use equals 100 lbs per 1,000 gal treated
		600,000	1,510,000	20 gpm flow rate	
		1,100,000	3,630,000	50 gpm flow rate	
		1,600,000	7,100,000	100 gpm flow rate	
	Activated carbon contact beds for mid-canyon extracted groundwater	330,000	400,000	10 gpm flow rate	Assumes carbon use equals 40 lbs per 1,000 gal treated
		500,000	700,000	20 gpm flow rate	
		900,000	1,580,000	50 gpm flow rate	
		1,300,000	3,000,000	100 gpm flow rate	

Subsection No.	Process	Estimated Capital Cost, $ (1)	Estimated O&M Cost $/YR	Basis for Cost Estimating	
	Activated carbon contact beds for lower canyon and community extracted groundwater	200,000	140,000	10 gpm flow rate	Assumes carbon use equals 3 lbs per 1,000 gal treated
		300,000	170,000	20 gpm flow rate	
		550,000	280,000	50 gpm flow rate	
		800,000	440,000	100 gpm flow rate	
4.2.21	Reverse osmosis for mid-canyon extracted groundwater	35,000	24,000	10 gpm flow rate	
		70,000	34,000	20 gpm flow rate	
		170,000	60,000	50 gpm flow rate	
		340,000	120,000	100 gpm flow rate	
	Reverse osmosis for lower canyon and community extracted groundwater	30,000	22,000	10 gpm flow rate	
		60,000	30,000	20 gpm flow rate	
		150,000	56,000	50 gpm flow rate	
		300,000	112,000	100 gpm flow rate	
4.2.22	PACT™ system	300,000	130,000	10 gpm flow rate	
		600,000	250,000	20 gpm flow rate	
		1,350,000	480,000	50 gpm flow rate	
		1,800,000	840,000	100 gpm flow rate	
4.2.23	Disposal of liquids to POTW sewer line transported from the mid-canyon treatment plant; includes pipeline plant to Hwy 60	580,000	640,000	10 gpm flow rate	
		750,000	800,000	20 gpm flow rate	
		1,190,000	1,585,000	50 gpm flow rate	
		1,660,000	2,845,000	100 gpm flow rate	
	Disposal of liquids to POTW sewer line transported from the extraction well barrier area	280,000	454,000	10 gpm flow rate	
		450,000	743,000	20 gpm flow rate	
		900,000	1,524,000	50 gpm flow rate	
		1,130,000	2,780,000	100 gpm flow rate	
4.2.24	Disposal of liquids to solar evaporation ponds in Pyrite Canyon	3,850,000	120,000	10 gpm flow rate	
		6,800,000	200,000	20 gpm flow rate	
		12,700,000	340,000	50 gpm flow rate	
		20,000,000	600,000	100 gpm flow rate	
4.2.25	Disposal of liquids to off-site RCRA permitted facility transported from the mid-canyon treatment plant area	300,000	4,347,000	10 gpm flow rate	
		490,000	7,855,000	20 gpm flow rate	
		990,000	17,993,000	50 gpm flow rate	
		1,480,000	35,020,000	100 gpm flow rate	
	Disposal of liquids to off-site RCRA permitted facility transported from the extraction well barrier area	300,000	4,347,000	10 gpm flow rate	
		490,000	7,855,000	20 gpm flow rate	
		990,000	17,993,000	50 gpm flow rate	
		1,480,000	35,020,000	100 gpm flow rate	

Subsection No.	Process	Estimated Capital Cost, $[1]	Estimated O&M Cost $/YR	Basis for Cost Estimating
4.2.26	Discharge to treated liquids to surface waters	135,000	10,000	10 gpm flow rate
		250,000	10,000	20 gpm flow rate
		490,000	25,000	50 gpm flow rate
		660,000	30,000	100 gpm flow rate
4.2.27	Monitoring, sampling and analysis	---	200,000	POTW sewer line, reinjection or surface discharges.
		---	80,000	Solar evaporation on site.
		---	10,000	Off-site RCRA permitted facility discharge.
		---	100,000	Routine groundwater monitoring for on-site, and lower canyon. (Required regardless of disposal or mitigation alternative).

(1) Last quarter 1985 costs.

complete site remediation:

- on-site leachate management only;
- dewatering only;
- dewatering, excavation, treatment by neutralization, and RCRA cell construction; and
- dewatering, excavation, treatment by incineration and chemical stabilization and redisposal on-site.

The workplan and resulting report were made available for public review and comment. Following the public meeting in September, 1986, comments were received from Congressman Brown, the Community Technical Advisor (Environ) and community members. The Office of Technology Assessment was also contacted to obtain a listing of emerging technologies. In addition, SAIC staff and Stringfellow Project staff members attended a technologies workshop sponsored by Concerned Neighbors in Action.

Stringfellow Hazardous Waste Site Feasibility Study Report

Phase III - Detailed Screening of Alternatives

The Task XIV FS Report, released in June, 1988, is the culmination of the previous feasibility process reports. The Feasibility Study Process, and how these Reports fit into and document that process, is outlined on Table 1. Between the

Table 1

FEASIBILITY STUDY PROCESS

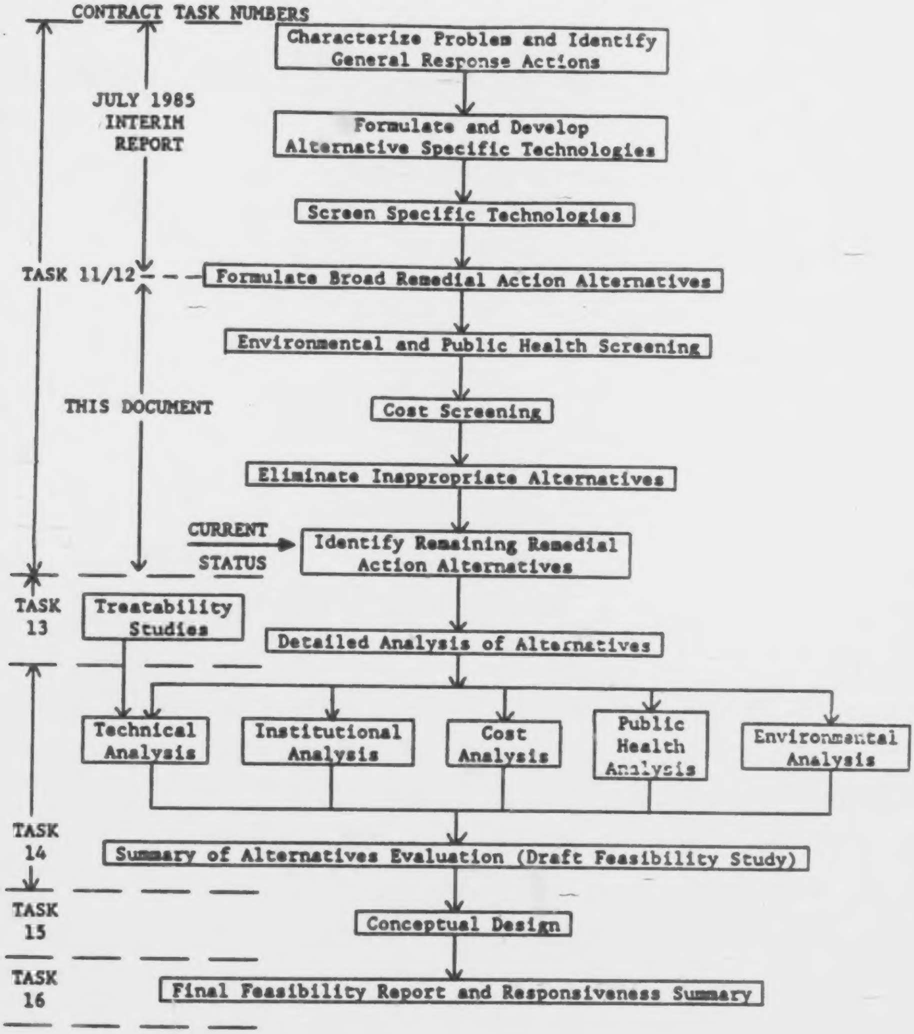
CONTRACT TASK NUMBERS
JULY 1985
INTERIM
REPORT
TASK 11/12
THIS DOCUMENT
CURRENT
STATUS
TASK
13
TASK
14
TASK
15
TASK
16
Characterize Problem and Identify General Response Actions
Formulate and Develop Alternative Specific Technologies
Screen Specific Technologies
Formulate Broad Remedial Action Alternatives
Environmental and Public Health Screening
Cost Screening
Eliminate Inappropriate Alternatives
Identify Remaining Remedial Action Alternatives
Treatability Studies
Detailed Analysis of Alternatives
Technical Analysis
Institutional Analysis
Cost Analysis
Public Health Analysis
Environmental Analysis
Summary of Alternatives Evaluation (Draft Feasibility Study)
Conceptual Design
Final Feasibility Report and Responsiveness Summary

Figure ES-1. Schematic Diagram of Feasibility Study Process and its Relationship to this Status Report, and the Project Contract Task Numbers release of the XI/XII Reports and the FS Report, the Superfund Amendments and Reauthorization Act (SARA) was passed. The RI/FS process and methodology for the screening of alternatives was changed by the provisions of SARA, specifically, SARA requires that remedial alternatives be evaluated using the following criteria:

1. Protection of human health and the environment
2. Attainment of applicable or relevant and appropriate requirements
3. Short term effectiveness
4. Long term effectiveness
5. Reduction of toxicity, mobility, and volume of hazardous materials
6. Implementability
7. Cost
8. Support agency acceptance
9. Community acceptance.

A detailed description of these SARA criteria will be provided by Jeff Zelikson of the Environmental Protection Agency.

As a result of SARA, the Task XIV Report provides a more detailed evaluation of the alternatives than is found in the Task XI/XII Report. Table 3 provides a list of the remedial alternatives that survived the Phase I and II screening processes.

Table 3

Remedial Action Technologies That Survived the Task XI/XII Screening Process

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UNCONTAMINATED SURFACE WATER/GROUNDWATER MANAGEMENT

Lowering of the Site Water Table (Dewatering)

Zone 1	Dewatering and hydraulic isolation using onsite extraction wells placed from the ground surface
Zone 1	Dewatering and hydraulic isolation using a gallery drainage system (adit)

Surface Water Controls

Zone 1	Multilayered cap system
Zone 1	Construction of stormwater channel at north end of Site (under design for construction in 1988)
Zone 1	Construction of stormwater channel at south end of Site (under design for construction in 1988)

WASTE AND CONTAMINATED SOIL CONTROL

Remove Soil

Zone 1	Excavation of digable contaminated soil from the Site and immediately below the barrier dam
Zone 1	Selective excavation of areas (hot spots) containing higher levels of contamination (added since Task XI/XII screening)

Soil Treatment

Zone 1	Onsite thermal treatment of excavated contaminated soil
Zone 1	Chemical fixation, stabilization, or solidification of excavated contaminated soil or incineration ash
Zone 1	Neutralization of excavated contaminated soil (deleted since Task XI/XII screening)
Zone 1	In-situ soil-gas extraction (added since Task XI/XII screening)
Zone 1	In-situ soil flushing (added since Task XI/XII screening)
Zone 1	Ex-situ soil washing (added since Task XI/XII screening)

Remedial Action Technologies That Survived the Task XI/XII Screening Process (Continued)

Soil/Sludge Disposal

Zone 1	Redispose excavated, treated soil onsite
All Zones	Truck sludges/solids and untreated soils to RCRA-permitted site

LEACHATE AND CONTAMINATED GROUNDWATER CONTROL

Groundwater Extraction

Zone 1	Onsite/upper mid-canyon contaminated groundwater and leachate extraction (partially in place at present)
Zone 2	Mid-canyon contaminated groundwater (plume) extraction (currently in place)
Zone 3	Lower canyon contaminated groundwater (plume) extraction (under design for construction in 1988)
Zone 4	Community contaminated groundwater (plume) extraction

Groundwater Treatment

Physical/Chemical

Zone 1	Chemical precipitation treatment of extracted groundwater
Zones 2,3,4	Air stripping treatment of extracted groundwater
All Zones	Granular activated carbon treatment of extracted groundwater
Zones 3,4	Reverse osmosis treatment of extracted groundwater

Biological

Zones 1,2	Biological treatment of extracted groundwater (deleted since Task XI/XII screening)
Zones 1,2	PACT process treatment of extracted groundwater

Remedial Action Technologies That Survived the Task XI/XII Screening Process (Continued)

	Disposal of Adequately Treated Groundwater or Other Liquid Emissions
Zones 3,4	Surface discharge of treated groundwater
Zones 3,4	Reinjection of treated groundwater into aquifer
All Zones	Solar evaporation pond disposal of treated/untreated groundwater
All Zones	POTW sewer line disposal of treated groundwater
Zones 3,4	Mechanical evaporation (added since Task XI/XII screening)
	Ancillary
All Zones	Pipeline transport of extracted groundwater
All Zones	Tank storage/flow equalization of extracted groundwater

The remedial alternatives recommended in the XI/XII Report were carried into the FS Report and modified to reflect new information and site data. Neutralization and biological treatment were deleted, while in-situ flushing, soil gas extraction, mechanical evaporation and in-situ soil washing were added. In accordance with EPA guidance, the technologies were further screened for technical feasibility, implementability and cost and combined into remedial alternatives representing a range of treatment and containment combinations. Six remedial alternatives resulted:

1. no action
2. natural flushing of on-site area and downgradient plume management
3. on-site dewatering, extraction and treatment of on-site leachate and downgradient plume management

4A. on-site dewatering, extraction and treatment of on-site leachate, soil gas extraction, in-situ flushing and downgradient plume management

4B. on-site dewatering, extraction and treatment of on-site leachate, soil gas extraction, selective soil excavation/treatment, in-situ flushing and downgradient plume management

5. excavation and treatment of all on-site diggable soil

These alternatives and their associated costs will be described in detail by Dr. Robert Shokes of Science Applications International Corporation.

Mr. **Brown**. Thank you, Jan.

Did you have a separate statement, Beth?

Ms. **Jines**. No.

Mr. **Brown**. All right, Mr. Petrilli, would you go through your presentation then, and try to make it interesting and short.

[Pause.]

STATEMENT OF JOE PETRILLI, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

Mr. **Petrilli** . Good morning.

My name is Joe Petrilli. I manage the Engineering Science Division for Science Applications International Corporation and I am sitting in for Bob Shokes, who is ill today. He is the project manager for the Stringfellow RI/FS, however, I participated quite fully in the Feasibility Study.

Mr. **Brown**. He did not get ill at the thought of coming up here, did he?

Mr. **Petrilli**. I cannot comment for him.

I will review the remedial actions that have been evaluated in the Feasibility Study, but first I would like to go over the various geographic zones of contamination at the site as these are important to understand why we have specific remedial actions for specific areas on the site.

In Zone 1, which is the upper area here, that contains the site itself and about 600 feet south of what we call the barrier extraction well system. In this area you have your heaviest groundwater contamination and also significant soil and surface soil contamination.

As you move down through Zone 2, which is called the upper midcanyon, this goes to the midcanyon barrier walls and in this area the surface and soil contaminations become less, virtually non-existent, and you get a less contaminated groundwater in this area.

Zone 1 groundwater is called Stream A, and in Zone 2, it is Stream B. I am just mentioning that because it comes up quite often in the analysis.

Zone 3 extends from the midcanyon extraction wall system to Highway 60. And in this zone you also have the contaminated groundwater with organics and some of the sulfates and nitrates in that area and as you can see, as you move down the canyon, the groundwater contamination becomes less and less, until you hit Zone 4, which is commonly called the community area.

This is the community of Glen Avon, and it goes from Highway 60 to the end of the plume. Here the groundwater contamination is at its lowest, but it is still too high to maintain a potable water supply, so cleanup must be taken in Zone 4 as well.

This is not to belabor the point; Jan kind of went over these already. These are the alternatives, actually the five alternatives that have been defined quite comprehensively in the Feasibility Study.

Briefly, Alternative 1 was only included as a comparison alternative; it is the no-action alternative and it is required by the National Contingency Plan.

Alternative 2 involves essentially a status quo at the site. That is natural flushing of the on-site area and downgradient plume management.

Alternative 3 involves on-site dewatering, extraction and treatment of on-site leachate and the downgradient plume management.

Alternatives 4A and 4B are the mixed treatment alternatives and they involve, besides what is the components of Alternative 3, in Alternative 4A you have the soil gas extraction and in-situ soil flushing. And in 4B you have the added component of selective excavation.

Alternative 5 involves the total excavation of the on-site itself and that soil would be treated to the point where it is innocuous and redisposed on-site. This also includes the downgradient plume management of all the other components.

I thought I would get into the groundwater—let us see, this goes this way, like that—into those groundwater remediation activities that are common to all of these alternatives. One of these components is the installation and operation of a lower canyon groundwater extraction well barrier, just north of Highway 60. This system will remove contaminated groundwater so it can be treated and will also retard further movement of contaminants south into the community groundwater system.

This network, by the way, is an early implementation action and is currently undergoing design and implementation this year.

South of Highway 60 in the community of Glen Avon—let's see—the cleanup goal is to stop the migration of the plume of the Stringfellow-related contaminants which is moving southward, past Jurupa Road there and so also to extract that groundwater that is contaminated and treat it and return it to drinking water standards.

This cleanup in Zone 4 is a key component to all the remedial alternatives undergoing detail evaluation.

This groundwater by the way, will be treated by extracting the contaminated groundwater from the center of the plume shown by the circle. It will be cleaned up and then reinjected in the wells on the sides, shown by the squares there, and so you will have a constant flushing of the groundwater in that area, until eventually it is clean. And this system will be a closed system so that there will be no contaminants moving any further than they already are.

I would like to just get briefly into the remedial alternatives themselves and the highlights of the remedial alternative number 2. This alternative is essentially a status quo alternative containing the components that are currently out there. The treatment plant, the extraction wells in the midcanyon area, as well as the future work in the lower canyon and community.

In Zone 1, the off-site area, this remediation just serves as a continuation of the present practice of removing contaminated leachate with extraction wells. Over a long period of time this natural flushing will result in removing the water soluble contaminants from the site.

Other major on-site actions include the construction of drainage channels in the northern area of the site as well as the reconstruction and implementation of a multi-layer cap on the site and continued extraction of the leachate.

Remedial Alternative 3 is an isolation alternative. What this does, it involves leaving contaminated soil and rock on site, but also lowering the water table so that by dewatering the site with either surface-based extraction wells, which are shown by the circles, or an added or drainage tunnel underneath the site, which is shown by the dashline. It would be either/or one of these components, by the way, they are both shown here for comparison purposes. This dewatering would remove a significant amount of the contaminated groundwater in the area and once the new water table is established it would have to be perpetually maintained so that on-site contaminants would remain isolated and would not move. Again, this alternative involves the downgradient plume management.

Alternative 4A begins to attempt to accelerate cleanup of groundwater in the on-site area. This is done by using, first of all, dewatering, using the extraction wells or the tunnel. And then implementing soil gas extraction, which is done after the water table is lowered and is more effective in the dryer soils. It is done by installing probes and physically withdrawing of volatile contaminants from the soil and cleaning up the soil in that way.

Once those contaminants are removed, then a flushing action is taken, very similar to the one mentioned in the community where you are actually placing water into the ground and moving the contaminants from the rock and the soil.

This flushed-out water would be collected in the dewatering system, so it is again a closed system. And that is how your cleanup would be achieved on-site in that area.

Another component of this action is a—turn that around and flip it, there you go, thanks—would be an accelerator approach as well in the midcanyon, where we would call additional extraction wells to be installed, north and south of the existing midcanyon extraction well barrier to accelerate the removal of the contaminated groundwater plume.

Remedial action 4B is the same as the one I have just mentioned, except we are interposing selective excavation and treatment of soils after the in-situ soil gas extraction, after the gas has been removed, and before the soil flushing occurs.

The selective excavation action involves physically removing identified hot spots; that is areas that have shown higher contamination than the rest of the site, that is in the soil. This soil would be excavated and would either be incinerated or washed, chemically treated and redisposed of back on site.

Remedial Alternative 5 is the full-blown excavation of all the on-site contaminants. All of the contaminants on-site, all the soil, diggable soil, that is soil that could be excavated without using blasting or anything like that, would be excavated, hauled down to a treatment area on-site. Here again, it would either be incinerated or soil washed and then it would be redisposed of back on site, and that is what this schematic attempts to depict.

Again in Zones 2, 3 and 4, you would have the aggressive groundwater extraction, treatment and reinjection program handling the contaminated groundwater in Zones 2, 3 and 4.

All of these alternatives underwent comprehensive review as you can tell by the scope of the Feasibility Study itself with regard to effectiveness, implementability, and cost. Hearings today are very much along the lines of effectiveness because community acceptance is very important in this selection process.

Another area of effectiveness is just how long does it take to achieve the cleanup. This is done in this particular table and in the report, by using theoretical, analytical models. And what these models do is try to define when the water achieves the level so that it is a 10 - 6 carcinogenic risk. That is one person in one million drinking this water would be susceptible to cancer. And this is the established criteria in the guidance plan for SARA CERCLA.

What is shown in these particular cleanups, is then in Zones 3 and 4, all the remedial alternatives are equal. In Zone 4, which is the community cleanup, the groundwater can be achieved in ten years and in Zone 3, the forty-year period.

And then as you move in the upper midcanyon and on-site, where there is a lot more contamination and there are a lot more variations of technologies, things increase quite drastically in terms of years per cleanup.

Of course the big number is the cost number, and how did we determine cost. These estimated costs combine all of the downwater plume management costs that are to be expended, as well as the on-site costs. This particular slide—just move it a little over that way—shows the capital costs, or the costs that it takes to actually build the alternative and then the present worth dollars of these capital costs as well as the operation and maintenance costs; the O and M costs being those costs on an annual basis that it will take to maintain this for the full life of the alternative.

The discount rates mean the decreased value of money in time and what these costs then give you is a sensitivity analysis of costs for all five remedial alternatives; ranging from the low end of the status quo alternative to the very high end of the total excavation alternative.

This then concludes my analysis, or just brief overview, of the remedial alternatives for the site.

[The prepared statement of Dr. Shokes follows:]

TESTIMONY OF
ROBERT F. SHOKES, PH.D.
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL RESEARCH
AND ENVIRONMENT
AND THE CALIFORNIA STATE SENATE COMMITTEE ON APPROPRIATIONS

SEPTEMBER 10, 1988
GLEN AVON, CALIFORNIA

FEASIBILITY STUDY REPORT OVERVIEW
TECHNICAL/COST DESCRIPTIONS OF REMEDIAL ALTERNATIVES PROPOSED BY DHS AND EPA FOR STRINGFELLOW SITE CLEANUP

With the release of the Stringfellow Site Draft Feasibility Study (FS) Report on June 30, 1988, the State Department of Health Services (DHS) and the U.S. Environmental Protection Agency (EPA) presented detailed analyses of five remedial alternatives that address site-related contamination problems. One of these alternatives will be selected as the final remedy for the site and the community of Glen Avon. The selected remedy will include the DHS/EPA proposed plan for community groundwater cleanup (described on page 45 of this statement) that was also released on June 30, 1988 in conjunction with the FS final draft report.

Of the five remedial alternatives, two are "mixed treatment" alternatives. Mixed treatment is a term used by FS engineers to describe alternatives that would employ various combinations of in-situ treatment actions. (In the case of the Stringfellow Site, in-situ treatment refers to individual cleanup actions that can be performed without digging up and removing contaminated soils.) Two onsite in-situ actions, soil-gas extraction and soil flushing, are included in both of the mixed treatment alternatives that underwent detailed analysis.

Remedial alternatives presented as potential final cleanup options are numbered 2, 3, 4A, 4B, and 5. Alternative 1, the "No Action" alternative, would not only not employ any further remedial actions but would involve discontinuing onsite and mid-canyon groundwater extraction and treatment at the pretreatment plant. It is included in the FS only for comparison purposes to illustrate the threat to public health and the environment if nothing is done to control the migration of contamination from the site. Alternatives 4A and 4B are mixed treatment alternatives.

Each successive alternative expands upon the previous alternative and becomes more complex and as such, also more costly. However, some alternatives would utilize many of the same technologies. Following, are basic overviews describing key onsite cleanup actions of each remedial alternative as well as the estimated capital costs and operation and maintenance costs required for each remedial alternative to achieve its objectives.

Cost information for equipment, construction, operation and maintenance (O&M) for the various elements of the basic remedial alternatives presented herein was derived from vendor quotations, costs guides and other literature, cost estimates from other Stringfellow contractors, FS treatability studies, construction and operating data from the existing Stringfellow pretreatment plant and extraction well systems, and professional judgment based on previous engineering experience. General site/start-up costs (i.e., contractor mobilization, bonding, and temporary facilities; clearing, grading, and security fences; gravel and paving; buildings; and domestic water system) are incorporated in most technology capital costs estimates shown. However, general site/start-up costs were not included while developing the water treatment technology capital costs and are separately itemized in the remedial alternative cost tables.

Construction costs estimates for water extraction, treatment, and disposal are based on anticipated design flow rates. For operation and maintenance (O&M) cost estimates, anticipated average flow rates, typically less than design flow rates, were used. This is common practice in the water treatment field. In some cases, the flow rate for a given waste stream changes over time, thereby resulting in different O&M costs for each time period. An example is dewatering of the onsite area (Remedial Alternative No. 3) where the Stream A flow rate is 45 gpm for the initial year of dewatering and 10 gpm thereafter. The time to achieve cleanup also impacts the O&M costs of a given technology. For downgradient (lower canyon Stream C and community Stream D) groundwater plume management, estimated flow rates and cleanup times are the same for all basic remedial alternatives. For onsite and mid-canyon groundwater plume management (Streams A and B), however, estimated cleanup times and flow rates, and thus O&M costs, vary because of the use of different strategies and technologies between the remedial alternatives.

A labor rate of $50/hr is used for all O&M labor cost estimates. This is an average rate for all O&M and supervisory activities that is based on past experience at the Stringfellow Site. All electric power cost estimates are based on the current rate of $.10/kWhr.

The feasibility study level cost estimates presented herein have been prepared as guidance in remedial alternatives evaluation using information available at the time of the estimate. As stipulated in EPA FS guidance, FS cost estimates are required to have a +50/-30 percent accuracy for an identified scope. This is a typical level of accuracy for an order-of-magnitude cost estimate for a typical nonhazardous waste study with a defined scope. The final actual costs of a remedial alternative will depend on the labor and material costs, site conditions, productivity, and competitive market conditions at the time of implementation as well as final project scope, final project schedule, the firm selected for final engineering design, and other variable factors. As a result of these uncertainties regarding future conditions, the final remedial alternative costs will vary from the estimates presented herein. Therefore, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

Present worth costs, which represent the amount of money in today's dollars needed to cover all the expenditures associated with a remedial action alternative, have been calculated for each alternative in order to make costs comparisons on an equal basis for expenditures that occur over different time periods. Discounts rates of 3, 7, and 10 percent have been used, as requested by the Agencies, to determine present worth costs.

It should be noted that some of the alternatives have several variations. These variations involve alternate technologies that could be used to accomplish the same objective(s) within a remedial alternative. For example, the dewatering process could employ either surface extraction wells or a subsurface drainage gallery tunnel (adit) system. For economic or technological reasons, the feasibility study evaluates the use of the other technologies as alternatives for the basic unit process chain described herein.

The substitution of one technology for another is a "variation" in the remedial alternative and selecting between variations of a remedial alternative is termed a "subdecision". The major technology variations under consideration are:

- A subdecision regarding whether to dewater the onsite area (Zone 1) with surface extraction wells or with a subsurface drainage tunnel. This subdecision applies to all remedial alternatives except No. 2. Both technologies have strong advocates but the surface extraction-well variation was chosen as the basic variation over the subsurface drainage-tunnel variation primarily because of its much lower capital construction cost.
- A subdecision regarding whether to use air stripping (with emission controls) or GAC as a technology to remove organic contaminants during the treatment of extracted groundwater Streams C and D. This subdecision applies to all remedial alternatives. Both technologies were judged technically feasible and the air-stripping technology was selected as the basic variation because it has lower capital and O&M costs.
- A subdecision whether to use in-situ soil washing, incineration and chemical stabilization, or in-situ soil washing for volume reduction followed by incineration and/or chemical stabilization as a technology to treat excavated contaminated soil in RA Nos. 4B and 5. Based on a cursory evaluation of soil washing, a new technology, it was concluded that incineration and chemical stabilization is preferable as a basic variation to soil washing alone or soil washing followed by incineration and/or chemical stabilization.

For the purposes of comparison in this paper, process chain units only (i.e., basic variations) are discussed and costed out.

Description of Alternative 2 - Natural Flushing

This alternative involves natural flushing of the onsite area and downgradient plume cleanup. Basically, this is a continuation of the present practice of intercepting, extracting, and treating onsite leachate, Stream A; and polluted groundwater that has moved through the site into the mid-canyon area, Stream B.

Major onsite actions include:

- Construction of surface water runoff drainage channels at the north and south ends of the site;
- Regrading of the onsite surface and the installation of a new multilayered cap that extends below the barrier wall covering contaminated soil in the upper mid-canyon area;
- Continuation of present extraction of leachate in the barrier wall vicinity, and installation of additional leachate extraction wells just north of the subsurface barrier wall to capture more leachate before it migrates offsite.

No other actions would be implemented to minimize contamination of clean groundwater at the site or the migration of contaminated groundwater from the site. In this alternative, clean groundwater from further up the canyon flows into and mixes with the contaminated onsite soils and leachate, so clean groundwater is allowed to become contaminated. Over a long period of time the flow of groundwater naturally flushes out water soluble contaminants. Onsite and mid-canyon extractions wells would continue to intercept and remove contaminated groundwater.

Construction of surface drainage channels is an early implementation action that was formally approved by DHS and EPA in June 1987 as a key component of the final alternative selected for the site. It is included in all five alternatives. Construction is expected to begin later this year and be completed in 1989. The new channels will complete the site's existing system, diverting clean surface water away from the onsite area.

Estimated Cost of Alternative 2

Table 1 presents the estimated costs for the various elements of the basic version of RA No. 2. The total capital cost of RA No. 2 including contingencies and allowances is estimated to be about $44.6 million. A moderate scope contingency of 25 percent was used because this alternative does not include extensive actions in contaminated soil. The estimated total present worth costs at 3, 7, 10 percent discount rates are $226.6 million, $144.6 million, and $121.5 million, respectively.

Table 1. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 2

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000)		
				3%	7%	10%
1. Drainage channel improvements north of and south of the onsite (zone 1) area (early implementation action) (Appendix A.4 and A.5)	2,836	28	0-FF**	3,764	3,236	3,116
2. Multilayer cap to replace existing cap [approximately 17 acres to cover onsite (Zone 1) area] (Appendix A.3)	3,376	70	0-FF	5,697	4,376	4,076
3. Improvements to existing onsite extraction system just north and south of the subterranean barrier wall; approximately three new Stream A extraction wells and aboveground appurtenances (O&M for six wells total)	100	120	0-FF	4,079	1,814	1,300
4. Stream A (10 gpm) treatment at the existing mid-canyon pretreatment plant						
a) Chemical precipitation (Appendix A.18)	Existing	1,022	0-FF	33,890	14,594	10,220
b) Carbon adsorption (Appendix A.21)	Existing	312	0-FF	10,346	4,455	3,120
5. Stream B (20 gpm) mid-canyon (Zone 2) extraction well system and Stream B treatment system at the existing mid-canyon pretreatment plant						
a) Extraction (Appendix A.12)	Existing	147	0-162	4,859	2,100	1,470
b) Carbon Adsorption (Appendix A.21). Cost of leasing contactors is included in Stream A treatment	Existing	202	0-162	6,677	2,886	2,020
6. Stream C (70 gpm) lower canyon (Zone 3) extraction well system, interim storage, pump station and force main to mid-canyon pretreatment plant, tankage (two-100,000 gal tanks) and appurtenances at pretreatment plant	1,303	285	0-40	7,091	5,103	4,090
7. Stream D (1,160 gpm) community (Zone 4) extraction well system, pumps, and force main to transport water to interim lower canyon storage tanks (includes tanks) (Appendix A.14)	1,415	393	0-10	4,767	4,175	3,830

Table 1. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 2 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
8. Stream C and D pump station and force main to mid-canyon (Appendix A.15)	424	151	0-10	1,712	1,485	1,352
9. Addition to and expansion of the existing pre-treatment plant to accommodate Stream C and D treatment facilities in the mid-canyon (flow volume approximately 1230 gpm)						
a) Flow equalization storage tanks, three 500,000-gal coated steel tanks, 36-hr detention (Appendix A.17)	420	21	0-10	599	567	549
b) Air stripping towers including vapor-phase activated carbon adsorption system for air stripping tower exhaust (Appendix A.20)	915	509	0-10	5,257	4,490	4,043
c) Reverse osmosis system including mixed media filtration (Appendix A.23)	3,385	992	0-10	11,847	10,352	9,480
d) Final treated effluent storage tanks, six 500,000-gal coated steel tanks, 72-hr detention (Appendix A.17)	840	42	0-10	1,198	1,135	1,098
e) General site/startup costs at 20 percent of Stream C and D treatment facility capital costs*	1,112	--	--	1,112	1,112	1,112
10. Treatment of Stream C (70 gpm) only, after Stream D extraction has been discontinued						
a) Flow equalization storage tanks	(See No. 9(a) above)	21	11-40	306	132	76
b) Air stripping and carbon adsorption of stripping exhaust	(See No. 9(a) above)	200	11-40	2,917	1,262	727
c) Reverse osmosis and mixed media filtration	(See No. 9(c) above)	388	11-40	5,659	2,448	1,410

Table 1. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 2 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
d) Final treated effluent storage tanks	(See No. 9(d) above)	42	11-40	613	268	153
11. Treated Stream C and D effluent gravity pipeline to community area (Zone 4) and lower canyon (Zone 3) reinjection wells, including transport and reinjection (Appendix A.25)	1,535	326	0-10	4,316	3,825	3,538
12. Treated Stream C effluent transport to lower canyon area (Zone 3) and reinjection (Appendix A.25)	(See No. 11 above)	74	11-40	1,079	467	269
13. Testing of Stream and D treated effluent prior to reinjection, 1 test per each million gal (two 500,000-gal tanks) (Appendix A.27)	--	410	0-10	3,497	2,880	2,519
14. Testing of Stream C treated effluent prior to reinjection after Stream D extraction has been discontinued, 1 test per each 500,000 gal (Appendix A.27)	--	46	11-40	671	290	167
15. Treated Stream A and B effluent and reverse osmosis brine storage tanks						
a) Stream A and B, two 100,000-gal coated steel tanks planned for construction at mid-canyon pretreatment plant (Appendix A.17)	120	6	0-FF	319	206	180
b) Reverse osmosis brine, four 500,000-gal coated steel tanks (Appendix A.17)	560	28	0-40	1,207	933	834
16. Force main and pump stations to transport treated Streams A and BV, and reverse osmosis brine from tretment of Streams C and D from the mid-canyon to SARI (Appendix A.15)						
a) Stream A at 10 gpm, Stream B at 20 gpm, Streams C and D brine at 500 gpm	7,579	902	0-10	15,273	13,914	13,121

Table 1. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 2 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000)		
				3%	7%	10%
b) Stream A at 10 gpm, Stream B at 20 gpm, Stream C brine at 30 gpm	(see No. 16(a) above)	772	11-40	11,259	4,870	2,806
c) Stream A at 10 gpm, Stream B at 20 gpm	(see No. 16(a) above)	765	41-FF	7,777	730	169
17. Disposal of treated Streams A and B, and reverse osmosis brine from tretment of Streams C and D to SARI (Appendix A.27)						
a) Flow rates same as 16(a); one analysis per 200,000 gal for Streams A and B, and one analysis per 1 million gal for Streams C and D	--	3,707	0-10	31,621	26,036	22,778
b) Flow rates same as 16(b); Stream A and B analysis same as 17(a); one analysis per 500,000 gal for Stream C	--	825	11-40	12,032	5,204	2,998
c) Flow rates same as 16(c); one analysis per 200,000 gal	--	558	41-FF	5,672	532	123

Table 1. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 2 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
Subtotal	25,920		--	207,915	125,873	102,745
Bid Contingencies (15%)	3,888	--		3,888	3,888	3,888
Scope Contingencies (25%)	6,480	--		6,480	6,480	6,480
Subtotal	36,288	--				
Permitting and Legal (7%)	2,540	--		2,540	2,540	2,540
Services During Construction (8%)	2,903	--		2,903	2,903	2,903
Subtotal	41,731	--				
Engineering Design Cost (8%)	2,903	--		2,903	2,903	2,903
Total Capital Cost	44,634	--				
Total Present Worth				226,630	144,587	121,459

* Includes contractor mobilization, bonding, and temporary facilities; general site work such as clearing, security fences, and grading; gravel and paving; buildings' and domestic water system. No land purchases are included.

**Foreseeable Future

In this remedial alternative, as well as all other alternatives with the exclusion of RA 1, the No Action Alternative, the cost of the DHS/EPA proposed planned for the community groundwater cleanup, is included in the overall costs of the alternative. The DHS/EPA proposed plan is the most cost-effective of three options that were evaluated. Over the life of the project, total costs are estimated at $76.9 million.

In Table 1, as in all subsequent tables, it is important to note that the third column estimates the number of years of operation and maintenance (O&M) that will be needed. The estimated years of O&M are based upon the estimated times of implementation presented in the FS. Since the four zones at the site (i.e., onsite, mid-canyon, lower canyon, and community) take different times for cleanup, the O&M associated with each zone's cleanup varies accordingly. These variances in the length of time O&M is required for various cost items are reflected in the present worth totals. Because of these many length of time variances, an O&M total for the entire remedial alternative would be misrepresentative, and has therefore not been included in the table totals.

Present worth costs are impacted most by the expense of the chemical precipitation treatment of Stream A, reverse osmosis treatment of Streams C and D, and transport and discharge of effluent to the SARI line. For chemical precipitation, the life-cycle costs are only operation and maintenance (O&M). The capital cost of reverse osmosis, $3.385 million, is a significant portion of its present worth. The cost of installing an effluent pipeline to the POTW sewer plus O&M costs for disposal fees are both significant effluent disposal expenditures.

Description of Alternative 3 - Isolation Strategy

This alternative involves onsite dewatering to lower the water table, extraction and treatment of onsite leachate, and downgradient plume cleanup. Essentially, the onsite element of this alternative leaves contaminated soil and rock in place. Dewatering results in a lowering of the water table that would isolate contaminated soils so they no longer come in contact with uncontaminated groundwater and surface water. Minimizing contact between onsite contaminants and uncontaminated groundwater infiltrating into the site will greatly reduce the quantity of contaminants migrating from Zone 1. Dewatering could be accomplished with either surface-based extraction wells or a subsurface gallery drainage tunnel.

Major onsite actions include:

- Construction of surface water runoff channels at the north and south ends of the site;
- Initial dewatering of the onsite area to extract and drain a significant portion of contaminated groundwater present, followed by perpetual maintenance dewatering to maintain the lowered water table and to intercept contaminated groundwater to the maximum extent possible before it leaves the onsite area;
- Intercepting uncontaminated groundwater before it enters the contaminated material;
- Treatment and disposal of contaminated leachate;
- Regrading the onsite surface and installing a new multilayered cap that also covers the upper mid-canyon area.

In this alternative, the dewatering system is not intended to clean up the Stringfellow Site. Either surface-based extraction wells (basic dewatering option) or the gallery drainage tunnel (dewatering variation) would initially remove a significant slug of contaminated groundwater. The groundwater table would be lowered approximately to the top of the bedrock. Existing contaminated soil and rock would remain in place along with some residual fluids in the drained ground above the final water table. By keeping clean water from mixing with the mass of contaminated soil and rock the contamination of clean groundwater and the migration of contaminated groundwater from the site would be minimized.

The mid-canyon extraction well barrier would continue to operate, removing any contaminated groundwater that migrates from Zone 1. Stream B would be treated at the existing Stringfellow pretreatment plant.

Estimated Costs of Alternative 3

Table 2 presents the estimated costs for the various elements of the basic version of RA No. 3. The total capital cost of RA No. 3 including contingencies and allowances is estimated to be about $48.9 million. A moderate scope contingency of 25 percent was used because this alternative does not include extensive actions in contaminated soil. The estimated total present worth costs at 3, 7, and 10 percent discount rates are $293.4 million, $177.7 million, and $146.9 million, respectively.

Present worth costs are impacted most by the expense of onsite dewatering and treatment, reverse osmosis treatment of Stream C and D, and transport and discharge of effluent to the SARI line.

Description of Alternative 4A - Mixed Treatment

This alternative involves onsite dewatering to lower the water table, extraction and treatment of onsite leachate, in-situ soil-gas extraction, in-situ soil flushing, and downgradient plume cleanup. After initial dewatering, in-situ actions accelerate cleanup in Zone 1 (onsite) while additional extraction and reinjection wells are included for Zone 2, the mid-canyon area. In-situ soil-gas extraction would remove volatile organic contaminants from contaminated soils while in-situ flushing of the soil with clean water would remove remaining water soluble organics. Volatile, water soluble organic contaminants (primarily TCE) are the major toxic organic contaminants found in the contaminant plume that extends into Glen Avon. This category of contaminants poses the highest exposure risk to the public.

Major onsite actions include:

- Construction of surface water runoff drainage channels at the north and south ends of the site;
- Dewatering the onsite area to lower the water table, which would remove a significant portion of the onsite contaminated water allowing the soil mass to sufficiently dry out so soil-gas extraction could be performed;

Table 2. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 3

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
1. Drainage channel improvements north of and south of the onsite (Zone 1) area (early implementation action) (Appendix A.4 and A.5)	2,836	28	0-FF**	3,764	3,236	3,116
2. Multilayer cap to replace existing cap [approximately 20 acres to cover onsite area and area in upper mid-canyon just south of the subterranean barrier dam] (Appendix A.3)	3,972	82	0-FF	6,691	5,143	4,792
3. Surface extraction well system to dewater the onsite area (Zone 1), including about 31 wells, 20 monitoring wells, interim storage tanks, and other appurtenances (Appendix A.1)	1,982	1,082	0-FF	64,389	28,857	20,802
4. (A) Extracted Stream A treatment at the existing mid-canyon plant; for the initial year of dewatering, the flow volume is estimated at 45 gpm						
a) Chemical precipitation (Appendix A.18)	Existing	3,788	0-1	3,678	3,540	3,444
b) Carbon adsorption (Appendix A.21)	Existing	986	0-1	957	922	896
(B) After dewatering is complete (i.e., water table lowered to just below bedrock), an estimated 10 gpm extraction flow volume maintains the lowered water table in perpetuity						
a) Chemical precipitation (Appendix A.18)	Existing	1,022	2-FF	32,902	13,639	9,291
b) Carbon adsorption (Appendix A.21)	Existing	312	2-FF	10,045	4,164	2,836
5. Stream B (20 gpm) mid-canyon (Zone 2) extraction well system and Stream B treatment system at the existing mid-canyon pretreatment plant						
a) Extraction (Appendix A.12)	Existing	147	0-162	4,859	2,100	1,470

Table 2. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 3 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000)		
				3%	7%	10%
b) Carbon Adsorption (Appendix A.21). Cost of leasing contactors is included in Stream A treatment	Existing	202	0-162	6,677	2,886	2,020
6. Stream C (70 gpm) lower canyon (Zone 3) extraction well system, interim storage, pump station and force main to mid-canyon pretreatment plant, tankage (two-100,000 gal tanks) and appurtenances at pretreatment plant (early implementation action) (Appendix A.13)	1,303	285	0-40	7,891	5,103	4,090
7. Stream D (1160 gpm) community (Zone 4) extraction well system, pumps, and force main to transport water to interim lower canyon storage tanks (includes tanks) (Appendix A.14)	1,415	393	0- 10	4,767	4,175	3,830
8. Stream C and D pump station and force main to mid-canyon (Appendix A.15)	424	151	0- 10	1,712	1,485	1,352
9. Addition to and expansion of the existing pretreatment plant to accommodate Stream C and D treatment facilities in the mid-canyon (flow volume approximately 1230 gpm)						
a) Flow equalization storage tanks, three 500,000-gal coated steel tanks, 36-hr detention (Appendix A.17)	420	21	0-10	599	567	549
b) Air stripping towers including vapor-phase activated carbon adsorption system for air stripping tower exhaust (Appendix A.20)	915	509	0-10	5,257	4,490	4,043
c) Reverse osmosis system including mixed-media filtration (Appendix A.23)	3,385	992	0-10	11,847	10,352	9,480
d) Final treated effluent storage tanks, six 500,000-gal coated steel tanks, 72-hr detention (Appendix A.17)	840	42	0-10	1,198	1,135	1,098

Table 2. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 3 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
e) General site/startup costs at 20 percent of Stream C and D treatment facility capital costs[a]	1,112	--	--	1,112	1,112	1,112
10. Treatment of Stream C (70 gpm) only, after Stream D extraction has been discontinued						
a) Flow equalization storage tanks	(See No. 9(a) above)	21	11-40	306	132	76
b) Air stripping and carbon adsorption of stripping exhaust	(See No. 9(a) above)	200	11-40	2,917	1,262	727
c) Reverse osmosis and mixed media filtration	(See No. 9(c) above)	388	11-40	5,659	2,448	1,411
d) Final treated effluent storage tanks	(See No. 9(d) above)	42	11-40	613	265	153
11. Treated Stream C and D effluent gravity pipeline to community area (Zone 4) and lower canyon (Zone 3), including transport and reinjection (Appendix A.25)	1,535	326	0-10	4,316	3,825	3,538
12. Treated Stream C effluent transport to lower canyon area (Zone 3) and reinjection (Appendix A.25)	(See No. 11 above)	74	11-40	1,079	467	269
13. Testing of Stream C and D treated effluent prior to reinjection; 1 test per each million gal (two 500,000-gal tanks) (Appendix A.27)	--	410	0-10	3,497	2,880	2,519
14. Testing of Stream C treated effluent prior to reinjection after Stream D extraction has been discontinued; 1 test per each 500,000 gal (Appendix A.27)	--	46	11-40	671	290	167

Table 2. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 3 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
15. Treated Stream A and B effluent and reverse osmosis brine storage tanks						
a) Stream A and B, two 100,000-gal coated steel tanks planned for construction at mid-canyon pretreatment plant (Appendix A.17)	120	6	0-FF	319	206	180
b) Reverse osmosis brine, four 500,000-gal coated steel tanks (Appendix A.17)	560	28	0-40	1,207	933	833
16. Force main and pump stations to transport treated Streams A and B and reverse osmosis brine from treatment of Streams C and D from the mid-canyon to SARI (Appendix A.15)						
a) Stream A at 45 gpm, Stream B at 20 gpm, Streams C and D brine at 500 gpm	7,379	950	0-1	8,501	8,467	8,443
b) Stream A at 10 gpm, Stream B at 20 gpm, Stream C and D brine at 500 gpm	(see No. 16(a) above)	902	2-10	6,819	5,492	4,722
c) Stream A at 10 gpm, Stream B at 20 gpm, Stream C brine at 30 gpm	(see No. 16(a) above)	772	11-40	11,259	4,870	2,806
d) Stream A at 10 gpm and Stream B at 20 gpm	(see No. 16(c) above)	765	41-FF	7,777	730	169
17. Disposal of treated Streams A and B, and reverse osmosis brine from treatment of Streams C and D to SARI (Appendix A.27)						
a) Flow rates same as 16(a); one analysis per 200,000 gal for Streams A and B, and one analysis per 1 million gal for Streams C and D	--	3,992	0-1	3,867	3,731	3,629

Table 2. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 3 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
b) Flow rates same as 16(a); analysis same as 17(a)	--	3,707	2-10	28,022	22,572	19,408
c) Flow rates same as 16(c); one analysis per 200,000 gal for Streams A and B, and one analysis per 500,000 gal for Stream C	--	825	11-40	12,032	5,204	2,998
d) Flow rate same as 16(d); one analysis per 200,000 gal	--	558	41-FF	5,672	532	123
Subtotal	28,398		--	272,889	157,210	126,393
Bid Contingencies (15%)	4,260	--		4,260	4,260	4,260
Scope Contingencies (25%)	7,100	--		7,100	7,100	7,100
Subtotal	39,757	--				
Permitting and Legal (7%)	2,783	--		2,783	2,783	2,783
Services During Construction (8%)	3,181	--		3,181	3,181	3,181
Subtotal	45,721	--				
Engineering Design Cost (8%)	3,181	--		3,181	3,181	3,181
Total Capital Cost	48,901	--				
Total Present Worth				293,392	177,713	146,896

* Includes contractor mobilization, bonding, and temporary facilities; general site work such as clearing, security fences, and grading; gravel and paving; buildings' and domestic water system. No land purchases are included.

**Foreseeable future.

- Installing and operating in-situ soil-gas extraction systems to remove volatile organics remaining in the unsaturated mass of contaminated soil;
- After soil-gas extraction, implement in-situ soil flushing using clean water to wash out water soluble organics that were not removed during initial dewatering;
- Continuing to operate the dewatering system to remove flushing water;
- Treating all contaminated water removed from the site at the existing pretreatment plant.

Dewatering of the onsite area would be conducted in the same manner as described in Alternative 3. The objective of dewatering is to remove a significant portion of contaminated groundwater and minimize the flow of groundwater into the onsite soil mass. Soil-gas extraction can only be performed in unsaturated soils.

FS engineers estimate that approximately 1,000 soil-gas extraction wells would be needed to cover the 20 acres of the onsite and upper mid-canyon areas. A suction device connected to each well generates a vacuum that causes air to flow between the particles of unsaturated, contaminated soils. The extracted air contains both volatile, gaseous organics and water vapor. A water/gas condenser located on the surface separates the vapor from the extracted air. The separated water would be treated at the Stringfellow pretreatment plant. Volatile organics would be removed from the extracted air by an activated carbon adsorption treatment unit.

In-situ soil flushing would involve installation of an underground piping system placed just under the surface that dispenses clean water into contaminated soil in the onsite and upper mid-canyon areas. Clean water would mix with clean groundwater that naturally flows into the site, flushing out water soluble contaminants from the soil. Repeated cycles of soil flushing would remove mobile organic and inorganic contaminants present in onsite soils that dissolve in groundwater and move with it. Water containing flushed out contaminants percolates downward to the water table for collection by the previously installed dewatering system. Some of these contaminants include TCE, chloroform, sulfates, and nitrates. Successive flushing will also raise the pH of the onsite groundwater, making it less acidic which further reduces the mobility of metals in groundwater.

Both in-situ soil-gas extraction and in-situ soil flushing technologies are considered to be innovative, experimental technologies at large sites containing a heterogeneous mix of contaminants. If this alternative is selected it will be necessary to conduct field tests during the design phase to verify the effectiveness of these technologies. Initially, only dewatering plus soil-gas extraction may be approved for implementation. The use of soil-flushing may depend on the results from those tests.

In Zone 2, Alternative 4A proposes an accelerated cleanup of the plume. It calls for additional extraction wells north and south of the existing mid-canyon well barrier to speed up the removal of contaminated groundwater. Treated Stream D, and possibly treated Stream C groundwater, could also be reinjected back into the underground water system in this zone to further quicken cleanup of the plume.

Estimated Costs of Alternative 4A

Table 3 presents the estimated costs for the various elements of the basic version of Alternative 4A. The total capital cost of RA No. 4A including contingencies and allowances is estimated to be about $69.4 million. A scope contingency of 30 percent was used. This contingency is 5 percent greater than the contingency used in RAs 2 and 3 to account for uncertainties in utilizing soil gas and soil flushing technologies. The estimated total present worth costs at 3, 7, and 10 percent discount rates are $333.4 million, $217.3 million, and $180.4 million, respectively.

Present worth costs are impacted most by the expense of onsite dewatering and treatment, soil-gas extraction, reverse osmosis treatment of Streams C and D, and transport and discharge of effluent to the SARI line.

Table 3. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4A

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
1. Drainage channel improvements north and south of the onsite (Zone 1) area (early implementation action) (Appendix A.4 and A.5)	2,836	28	0-FF**	3,746	3,236	3,116
2. Surface extraction well system to dewater the onsite area (Zone 1), including about 31 wells, 20 monitoring wells, interim storage tanks, and other appurtenances (Appendix A.1)	1,982	1,882	0-3	7,305	6,921	6,662
3. (A) Extracted Stream A treatment at the existing mid-canyon plant; for the initial year of dewatering, the flow volume is estimated at 45 gpm						
a) Chemical precipitation (Appendix A.18)	Existing	3,788	0-1	3,678	3,540	3,444
b) Carbon adsorption (Appendix A.21)	Existing	986	0-1	957	922	896
(B) After dewatering is complete (i.e., water table lowered to just below bedrock), an estimated 10 gpm of extraction flow maintains the lowered water table during the 2 years while soil-gas extraction is being implemented						
a) Chemical precipitation (Appendix A.18)	Existing	1,022	2-3	1,899	1,727	1,612
b) Carbon adsorption (Appendix A.21)	Existing	312	2-3	580	527	492
(C) Stream A treatment system at 25 gpm for 62 years at the existing mid-canyon pretreatment plant						
a) Chemical precipitation (Appendix A.18)	Existing	2,225	4-66	57,330	25,581	16,676
b) Carbon adsorption (Appendix A.21)	Existing	600	4-66	15,460	6,898	4,497

Table 3. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4A (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
4. Soil-gas extraction system within onsite (Zone 1) area utilizing about 970 wells and 20 suction blower plus exhaust treatment facilities, estimated to require about 2 years (Appendix A.29)	12,515	--	2-3	12,515	12,515	12,515
5. In-situ soil flushing system within onsite (Zone 1) area utilizing near surface pipe grid to distribute flushing water. Extraction of flushing water done with same wells used in site dewatering (No. 2 above), supplemented by about 10 additional wells. Flushing estimated to continue about 62 years (Appendix A.9).	1,765	2,025	4-66	53,942	25,047	16,942
6. Stream B (20 gpm) mid-canyon (Zone 2) extraction well system and Stream B treatment system at the existing mid-canyon pretreatment plant						
a) Extraction (Appendix A.12)	Existing	147	0-46	3,642	2,007	1,452
b) Carbon adsorption (Appendix A.21) Cost of leasing contactors is included in Stream A treatment.	Existing	202	0-46	5,005	2,757	1,995
7. Stream C (70 gpm) lower canyon (Zone 3) extraction well system, interim storage, pump station and force main to mid-canyon pretreatment plant, tankage (two-100,000 gal tanks) and appurtenances at pretreatment plant (early implementation action) (Appendix A.13)	1,303	285	0-40	7,891	5,103	4,090
8. Stream D (1,160 gpm) community (Zone 4) extraction well system, pumps, and force main to transport water to interim lower canyon storage tanks (includes tanks) (Appendix A.14)	1,415	393	0-10	4,767	4,175	3,830
9. Stream C and D pump station and force main to mid-canyon (Appendix A.15)	424	151	0-10	1,712	1,485	1,352

Table 3. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4A (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
10. Addition to and expansion of the existing pretreatment plant to accommodate Stream C and D treatment facilities in mid-canyon (flow volume approximately 1230 gpm)						
a) Flow equalization storage tanks, three 500,000-gal coated steel tanks, 36-hr detention (Appendix A.17)	420	21	0-10	599	567	549
b) Air stripping towers including vapor-phase activated carbon adsorption system for air-stripping tower exhaust (Appendix A.20)	915	509	0-10	5,257	4,490	4,043
c) Reverse osmosis system including mixed media filtration (Appendix A.25)	3,385	992	0-10	11,847	10,352	9,480
d) Final treated effluent storage tanks, six 500,000-gal coated steel tanks, 72-hr detention (Appendix A.17)	840	42	0-10	1,198	1,135	1,098
e) General site start-up costs at 20 percent of Stream C and D treatment facilities capital costs	1,112	--	--	1,112	1,112	1,112
11. Treatment of Stream C (70 gpm) only, after Stream D extraction has been discontinued						
a) Flow equalization storage tanks	(see No. 10(a) above)	21	11-40	306	132	76
b) Air stripping and carbon adsorption of stripping exhaust	(see No. 10(b) above)	200	11-40	2,917	1,262	727
c) Reverse osmosis and mixed-media filtration	(see No. 10(c) above)	288	11-40	5,659	2,448	1,410
d) Final treated effluent storage tanks	(see No. 10(d) above)	42	11-40	613	265	153

Table 3. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4A (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000)		
				3%	7%	10%
12. Treated Streams C and D effluent transport to lower canyon area (Zone 3) and reinjection (Appendix A.25)	1,535	326	0-10	4,316	3,825	3,538
13. Treated Stream C effluent transport to lower canyon area (Zone 3) and reinjection (Appendix A.25)	(see No. 12 above)	74	11-40	1,079	467	269
14. Treated Streams C and D effluent gravity pipeline to mid-canyon (Zone 2) and reinjection wells, including transport and reinjection (Appendix A.25)	214	82	0-40	2,109	1,307	1,016
15. Testing of Streams C and D treated effluent prior to reinjection, 1 test per each million gal (two 500,000-gal tanks) (Appendix A.27)	--	410	0-10	3,497	2,880	2,519
16. Testing of Stream C treated effluent prior to reinjection after Stream D extraction has been discontinued, 1 test per each 500,000 gal (Appendix A.27)	--	46	11-40	671	290	167
17. Treated Streams A and B effluent and reverse osmosis brine storage tanks						
a) Streams A and B, two 100,000-gal coated steel tanks planned for construction at mid-canyon pretreatment plant	120	6	0-66	292	205	180
b) Reverse osmosis brine, four 500,000-gal coated steel tanks (Apendix A.17)	560	28	0-40	1,207	933	834
18. Force main and pump stations to transport treated Streams A and B, and reverse osmosis brine from treatment of Streams C and D, from the mid-canyon to SARI (Appendix A.15)						
a) Stream A at 45 gpm, Stream B at 20 gpm, Streams C and D at 500 gpm	7,579	950	0-1	8,501	8,467	8,443

Table 3. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4A (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
b) Stream A at 10 gpm, Stream B at 20 gpm, Streams C and D at 500 gpm		902	2-3	1,676	1,524	1,423
c) Stream A at 25 gpm, Stream B at 20 gpm, Streams C and D at 500 gpm		923	4-10	5,263	4,061	3,376
d) Stream A at 25 gpm, Stream B at 20 gpm, Stream C brine at 30 gpm		790	11-40	11,522	4,983	2,871
e) Stream A at 25 gpm, Stream B at 20 gpm		770	41-46	1,279	245	74
f) Stream A at 25 gpm		760	47-66	2,903	358	81
19. Disposal of treated Streams A and B and extracted Streams C and D to SARI (Appendix A.27)						
a) Flow rates same as 18(a); one analysis per 200,000 gal for A and B, 1 analysis per 1 million gal for C and D	--	3,992	0-1	3,876	3,731	3,629
b) Flow rates same as 18(b), analyses same as 19(a)	--	3,707	2-3	6,886	6,264	5,849
c) Flow rates same as 18(c), analyses same as 19(a)	--	3,834	4-10	21,859	16,867	14,024
d) Flow rates same as 18(d), with A and B analysis same as 19(a); one analysis per 500,000 gal for C		911	11-40	13,287	5,747	3,311
e) Flow rates same as 18(e), one analysis per 200,000 gal		594	41-46	986	189	57
f) Stream A at 25 gpm, one analysis per 200,000 gal		452	47-66	1,726	213	48

Table 3. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4A (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
Subtotal	38,920		--	302,891	186,759	149,927
Bid Contingencies (15%)	5,838	--		5,838	5,838	5,838
Scope Contingencies (30%)	11,676	--		11,676	11,676	11,676
Subtotal	56,434	--				
Permitting and Legal (7%)	3,950	--		3,950	3,950	3,950
Services During Construction (8%)	4,515	--		4,515	4,515	4,515
Subtotal	64,899	--				
Engineering Design Cost (8%)	4,515	--		4,515	4,515	4,515
Total Capital Cost	69,414	--				
Total Present Worth				333,385	217,252	180,421

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* Includes contractor mobilization, bonding, and temporary facilities; general site work such as clearing, security fences, and grading; gravel and paving; buildings; and domestic water system. No land purchases are included.

**Foreseeable future

Description of Alternative 4B - Mixed Treatment (Selective Excavation)

This alternative involves onsite dewatering to lower the water table, extraction and treatment of leachate, in-situ soil-gas extraction, selective soil excavation and treatment, in-situ soil flushing, and downgradient plume cleanup. It is similar to Alternative 4A except that the selective excavation and treatment action is interposed after soil-gas extraction and before soil flushing.

Major onsite actions include:

- Construction of surface channels at the north and south ends of the site;
- Onsite dewatering to lower the water table to remove the major portion of onsite contaminated leachate and prepare the site for soil-gas extraction;
- Implementing the soil-gas extraction process to remove volatile organic contaminants, followed by soil analysis of well hole samples;
- Excavation of soil from "hot spot" areas of higher contamination, followed by incineration to destroy organic contaminants, chemical stabilization to immobilize metals, and redisposal onsite;
- In-situ soil flushing to remove residual water soluble contaminants.

Dewatering, soil-gas extraction, and soil flushing would be conducted in the same manner as described in Alternative 4A. The dewatering system would also function as the collection system for flushed out water.

The wealth of data obtained from approximately 1,000 well holes drilled throughout Zone 1 during soil-gas extraction actions would accurately identify hot spot areas. Only diggable contaminated soil (removable with conventional earth moving equipment) would be excavated.

Thermal destruction would be performed onsite using portable rotary kiln incineration units equipped with air emissions control equipment. Treatability studies performed as part of the FS determined that rotary kiln incineration is the most efficient and cost-effective incineration method available for treating Stringfellow soils. Chemical stabilization would also be conducted onsite. Treatability studies determined that incinerated soils are best stabilized and solidified when combined with a sodium silicate/water mixture, cement, and water. Treated soil would be redisposed of onsite in lined cells that meet federal requirements for hazardous waste disposal.

Soil analysis data obtained from the drilling of soil-gas well holes and the selective excavation process should allow for accurate estimates regarding the type, quantity, and location of the remaining residual contaminants. In-situ soil flushing could be optimally designed, reducing the time required to flush water soluble contaminants from the site.

The accelerated cleanup approach proposed for Zone 2 described above in Alternative 4A also applies to Alternative 4B.

Estimated Cost of Alternative 4B

Table 4 presents the estimated costs for the various elements of the basic version of Alternative 4B. The total capital cost of RA No. 4B including contingencies and allowances is estimated to be about $247.9 million. The capital cost for incineration, element No. 6, is actually an equivalent capital cost; the incinerator is procured, not purchased. O&M costs for soil-gas extraction, selective excavation, incineration, and chemical stabilization have been treated as capital costs here because of the short duration of these elements. A scope contingency of 30 percent was used. This contingency was developed to reflect uncertainties in soil-gas extraction, soil flushing, partial soil excavation, and soil incineration elements. The estimated total present worth costs at 3, 7, and 10 percent discount rates are $504 million, $392.7 million, and $356.5 million, respectively.

Present worth costs are impacted most by the expense of onsite dewatering and treatment, soil incineration, and transport and discharge of treated effluent to the SARI line.

Table 4. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 48

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000)		
				3%	7%	10%
1. Drainage channel improvements north and south of the onsite (Zone 1) area (early implementation action) (Appendix A.4 and A.5)	2,836	28	0-FF**	3,764	3,236	3,116
2. Surface extraction well system to dewater the onsite area (Zone 1), including about 31 wells, 20 monitoring wells, interim storage tanks, and other appurtenances (Appendix A.1)	1,982	1,882	0-5	10,601	9,699	9,116
3. (A) Extracted Stream A treatment at the existing mid-canyon plant; for the initial year of dewatering, the flow volume is estimated at 45 gpm						
a) Chemical precipitation (Appendix A.18)	Existing	3,788	0-1	3,678	3,540	3,444
b) Carbon adsorption (Appendix A.21)	Existing	986	0-1	957	922	896
(B) After dewatering is complete (e.g., water table lowered to just below bedrock), an estimated 10 gpm of extraction flow maintains the lowered water table during the next 2 years while soil-gas extraction is implemented						
a) Chemical precipitation (Appendix A.18)	Existing	1,022	2-5	3,688	3,235	2,945
b) Carbon adsorption (Appendix A.21)	Existing	312	2-5	1,126	988	899
(C) Stream A treatment system at 25 gpm for 55 years at the existing mid-canyon pretreatment plant						
a) Chemical precipitation (Appendix A.18)	Existing	2,225	6-61	51,755	22,150	13,749

Table 4. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4B (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000)		
				3%	7%	10%
b) Carbon adsorption (Appendix A.21)	Existing	600	6-61	13,956	5,973	3,708
4. Soil-gas extraction system within onsite (Zone 1) area utilizing about 970 wells and 20 suction blower plus exhaust treatment facilities, requiring an estimated 2 years (Appendix A.29)	12,515	--	2-3	12,515	12,515	12,515
5. Excavation of selected areas of higher contamination onsite; cost estimate based on approximately 300,000 cu yd of excavated material (Appendix A.6)	14,000	--	4-5	14,000	14,000	14,000
6. Incineration of excavated material at a rate of approximately 21,000 tons/mo for about 2 years (Appendix A.7)	56,100	--	4-5	56,100	56,100	56,100
7. Chemically stabilize the incinerated material at a rate corresponding to incineration (Appendix A.8)	21,000	--	4-5	21,000	21,000	21,000
8. Redispose treated soil back into excavation (Appendix A.6)	(Included in No. 5 above)	--	4-5	(Included in No. 5 above)	(Included in No. 5 above)	(Included in No. 5 above)
9. In-situ soil flushing system within the onsite (Zone 1) area utilizing a near-surface pipe grid to distribute flushing water. Extraction of flushing water done with same wells used in site dewatering (No. 2 above) supplemented by about 10 additional wells. Flushing continues about 55 years (Appendix A.9).	1,765	2,025	6-61	48,868	21,924	14,278

Table 4. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4B (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000)		
				3%	7%	10%
10. Stream B (20 gpm) mid-canyon (Zone 2) extraction well system and Stream B treatment system at the existing mid-canyon pretreatment plant						
a) Extraction (Appendix A.12)	Existing	147	0-46	3,642	2,067	1,452
b) Carbon adsorption (Appendix A.21). Cost of leasing contactors is included in Stream A treatment	Existing	202	0-46	5,005	2,757	1,995
11. Stream C (70 gpm) lower canyon (Zone 3) extraction well system, interim storage, pump station and force main to mid canyon pretreatment plant, tankage (two-100,000 gal tanks) and appurtenances at pretreatment plant (early implementation action) (Appendix A.13)	1,303	285	0-40	7,891	5,103	4,090
12. Stream D (1160 gpm) community (Zone 4) extraction well system, pumps and force main to transport water to interim lower canyon storage tanks (includes tanks) (Appendix A.14)	1,415	393	0-10	4,767	4,175	3,830
13. Stream C and D pump station and force main to mid-canyon (Appendix A.15)	424	151	0-10	1,712	1,485	1,352
14. Addition to and expansion of the existing pretreatment plant to accommodate Streams C and D treatment facilities in mid-canyon (flow volume approximately 1230 gpm)						
a) Flow equalization storage tanks, three 500,000-gal coated steel tanks, 36-hr detention (Appendix A.17)	420	21	0-10	599	567	549

Table 4. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4B (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000)		
				3%	7%	10%
b) Air stripping towers including vapor-phase activated carbon adsorption system for air stripping tower exhaust (Appendix A.20)	915	509	0-10	5,257	4,490	4,043
c) Reverse osmosis system including mixed-media filtration (Appendix A.23)	3,385	992	0-10	11,847	10,352	9,480
d) Final treated effluent storage tanks, six 500,000-gal coated steel tanks, 72-hr detention (Appendix A.17)	840	42	0-10	1,198	1,135	1,098
e) General site startup costs at 20 percent of Streams C and D treatment facility capital costs*	1,112	--	--	1,112	1,112	1,112
15. Treatment of Stream C (70 gpm) only, after Stream D extraction has been discontinued						
a) Flow equalization storage tanks	(see No. 14(a) above)	21	11-40	306	132	76
b) Air stripping and carbon adsorption of stripping exhaust	(see No. 14(b) above)	200	11-40	2,917	1,262	727
c) Reverse osmosis and mixed-media filtration	(see No. 14(c) above)	388	11-40	5,659	2,448	1,410
d) Final treated effluent storage tanks	(see No. 14(d) above)	42	11-40	613	265	153

Table 4. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4B (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
16. Treated Streams C and D effluent gravity pipeline to community area (Zone 4) and lower canyon (Zone 3) and reinjection wells, including transport and reinjection (Appendix A.25)	1,535	326	0-10	4,316	3,825	3,538
17. Treated Stream C effluent transport to lower canyon area (Zone 3) and reinjection (Appendix A.25)	(see No. 16 above)	74	11-40	1,079	467	269
18. Treated Streams C and D effluent gravity pipeline to mid-canyon (Zone 2) reinjection wells, including transport and reinjection (Appendix A.25)	216	82	0-40	2,109	1,307	1,016
19. Testing of Streams C and D treated effluent prior to reinjection, 1 test per each million gal (two 500,000-gal tanks) (Appendix A.27)	--	410	0-10	3,497	2,880	2,519
20. Testing of Stream C treated effluent prior to reinjection after Stream D extraction has been discontinued, 1 test per each 500,000 gal (Appendix A.27)	--	46	11-40	671	290	167
21. Treated Streams A and B effluent and reverse osmosis brine storage tanks						
a) Streams A and B, two 100,000-gal coated steel tanks planned for construction at mid-canyon pretreatment plant (Appendix A.17)	120	6	0-61	287	204	180
b) Reverse osmosis brine, four 500,000-gal coated steel tanks (Appendix A.17)	560	28	0-40	1,207	933	834

Table 4. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4B (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000)		
				3%	7%	10%
22. Force main and pump stations to transport treated Streams A and B, and reverse osmosis brine from treatment of Streams C and D, from the mid-canyon to SARI (Appendix A.15)						
a) Stream A at 45 gpm, Stream B at 20 gpm, Streams C and D brine at 500 gpm	7,579	950	0-1	8,501	8,467	8,443
b) Stream A at 10 gpm, Stream B at 20 gpm, Streams C and D brine at 500 gpm		902	2-5	3,255	2,855	2,599
c) Stream A at 25 gpm, Stream B at 20 gpm, Streams C and D brine at 500 gpm		923	6-10	3,646	2,698	2,173
d) Stream A at 25 gpm, Stream B at 20 gpm, Stream C brine at 30 gpm		790	11-40	11,522	4,983	2,871
e) Stream A at 25 gpm, Stream B at 20 gpm		770	41-46	1,279	245	74
f) Stream A at 25 gpm		760	47-61	2,204	296	70
23. Disposal of treated Streams A and B and reverse osmosis brine (Streams C and D) to SARI (Appendix A.27)						
a) Flow rates same as 22(a); one analysis per 200,000 gal for A and B, 1 analysis per 1 million gal for C and D	--	3,992	0-1	3,876	3,731	3,629
b) Flow rates same as 22(b), analyses same as 23(a)	--	3,707	2-5	13,378	11,735	10,682
c) Flow rates same as 22(c), analyses same as 23(a)	--	3,834	6-10	15,146	11,208	9,024

Table 4. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 4B (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years of O&M	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
d) Flow rates same as 22(d); A and B analysis same as 23(a), one analysis per 500,000 gal for C	--	911	11-40	13,287	5,747	3,311
e) Flow rates same as 22(e), one analysis per 200,000 gal	--	594	41-46	986	189	57
f) Flow rates same as 22(f), one analysis per 200,000 gal	--	452	47-61	1,311	176	42
Subtotal	130,020		--	386,091	274,808	238,631
Bid Contingencies (15%)	19,503			19,503	19,503	19,503
Scope Contingencies (40%)	52,008	--		52,008	52,008	52,008
Subtotal	201,531	--				
Permitting and Legal (7%)	14,107	--		14,107	14,107	14,107
Services During Construction (8%)	16,122	--		16,122	16,122	16,122
Subtotal	231,761	--				
Engineering Design Cost (8%)	16,122	--		16,122	16,122	16,122
Total Capital Cost	247,883					
Total Present Worth				503,955	392,671	356,494

* Includes contractor mobilization, bonding, and temporary facilities; general site work such as clearing, security fences, and grading; gravel and paving; buildings; and domestic water system. No land purchases are included.

**Foreseeable future

Alternative 5 - Full Excavation

This alternative involves onsite dewatering to lower the water table, extraction and treatment of leachate, full excavation of all diggable soil and rock that is removable without blasting, incineration and chemical stabilization treatment followed by redisposal onsite into the excavation. The concept governing this option is that it is the most effective alternative for reducing contamination at the site; however, it would be the largest excavation project of this type ever conducted. In addition, onsite contamination extends into the decomposed granite and fractured bedrock well below the lower limits of the diggable soil layers; a residual mass of contaminants will remain, so it will be necessary to continue dewatering (extraction and treatment of onsite contaminated groundwater) for an extended number of years long after soil excavation, treatment, and redisposal actions are completed.

Major onsite actions include:

- Construction of surface water runoff drainage channels at the north and south ends of the site;
- Dewatering the onsite area to lower the water table, remove a significant portion of the onsite contaminated water, and desaturate the soil mass so excavation can be performed;
- Proceeding from north to south, excavating diggable contaminated soil and rock material located onsite and in the upper mid-canyon;
- Stockpiling contaminated soil in a specially-constructed building that protects soil from wind and rain, then segregating uncontaminated, lightly contaminated, and heavily contaminated soil;
- Treating contaminated soils so soil with high organic and metal contamination would be incinerated and chemically stabilized, while soils with minimal organic contamination and high levels of metal contamination would only undergo chemical stabilization;
- Stockpiling treated soil and redisposing of it onsite in lined cells;
- Installing a multilayered cap to prevent infiltration of surface water into treated soils;

- Continuing to operate the onsite dewatering system as long as necessary to clean up remaining groundwater;
- Treating all contaminated water removed from the site at the existing pretreatment plant.

Full excavation includes removal of the onsite cap, soil in the alluvium layer, diggable decomposed granite and rock, and soil from the sides of the onsite area. Excavation would also include the upper mid-canyon area south of the subsurface barrier wall and possibly the barrier wall itself. FS engineers estimate that approximately 1.35 million cubic yards of contaminated material would be dug up. Approximately 920,000 cubic yards is heavily contaminated. When removed from the ground this soil would swell by approximately 25 percent creating about 1.7 million cubic yards of loose soil. In terms of weight, the total mass of removable soil is estimated at 1.6 million tons.

Since it is not possible to remove all diggable material at once, a continuous cycle of excavation, treatment, and redisposal would occur with appropriate stockpiling prior to and after treatment. It is estimated that this process could take up to five years to complete.

Cleanup in Zone 2 would be the same as Alternatives 4A and 4B.

Estimated Cost of Alternative No. 5

Table 5 presents the estimated costs for the various elements of the basic version of Alternative 5. The total capital cost of RA No. 5, including contingencies and allowances, is estimated to be $595 million. O&M costs for soil excavation, incineration, and chemical stabilization have been treated as capital costs here because of the short duration of these elements. A scope contingency of 40 percent was used. This contingency was developed to reflect uncertainties in soil excavation and incineration. The estimated total present worth costs at 3, 7, and 10 percent discount rates are $812.2 million, $722.5 million, and $692.8 million, respectively.

Table 5. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 5

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
1. Drainage channel improvements north and south of the onsite (Zone 1) area (early implementation action) (Appendix A.4 and A.5)	2,836	28	0-FF**	3,764	3,236	3,116
2. Surface extraction well system to dewater the onsite area (Zone 1), including about 31 wells, 20 monitoring wells, interim storage tanks, and other appurtenances (Appendix A.1)	1,982	1,882	0-63	54,971	28,489	20,756
3. (A) Extracted Stream A treatment at the existing mid-canyon plant; for the initial year of dewatering, the flow volume is estimated at 45 gpm						
a) Chemical precipitation (Appendix A.18)	Existing	3,788	0-1	3,678	3,540	3,444
b) Carbon adsorption (Appendix A.21)	Existing	986	0-1	957	922	896
(B) After dewatering is complete (e.g., water table is lowered to just below bedrock surface) maintenance of the lowered water table requires an estimated extraction flow volume of 10 gpm. The time period projected for excavation and redisposal is about 5 years						
a) Chemical precipitation (Appendix A.18)	Existing	1,022	2-63	27,783	13,439	9,266
b) Carbon adsorption (Appendix A.21)	Existing	312	2-63	8,482	4,103	2,829
4. Excavation of digable material onsite; cost estimate based on approximately 1,350,000 cu yd of excavated material. Of this amount about 260,000 cu yd is uncontaminated and temporarily stockpiled (Appendix A.6)	40,920	--	2-6	40,920	40,920	40,920

Table 5. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 5 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 5%	7%	10%
5. Incineration of excavated organically contaminated material at a rate of about 26,000 tons per month for 5 years. In total about 1.60 million tons (0.92 million cu yd) incinerated (Appendix A.7)	156,000	--	2-6	156,000	156,000	156,000
6. Chemical stabilization of the incinerated material (see No. 5 above) plus an estimated additional 170,000 cu yd which is not incinerated but contains heavy metals. In total about 1.09 million cu yd (1.76 million tons) to be chemically stabilized (Appendix A.8)	90,504	--	2-6	90,504	90,504	90,504
7. Redisposal of excavated treated soil back into excavation (Appendix A.6)	(Included in No. 4 above)	--	2-6	(Included in No. 4 above)	(Included in No. 4 above)	(Included in No. 4 above)
8. Stream B (20 gpm) mid-canyon (Zone 2) extraction well system and Stream B treatment system at the existing mid-canyon pretreatment plant						
a) Excavation (Appendix A.12)	Existing	147	0-46	3,442	2,007	1,452
b) Carbon adsorption (Appendix A.21). Cost of leasing contactors is included in Stream A treatment	Existing	202	0-46	5,085	2,757	1,995
9. Stream C (70 gpm) lower canyon (Zone 3) extraction well system, interim storage, pump station and force main to mid-canyon pretreatment plant, tankage (two-100,000 gal tanks) and appurtenances at pretreatment plant (early implementation action) (Appendix A.13)	1,303	285	0-40	7,891	5,103	4,090
10. Stream D (1160 gpm) community (Zone 4) extraction well system, pumps and force main to transport water to interim lower canyon storage tanks (includes tanks) (Appendix A.14)	1,415	395	0-10	4,767	4,175	3,830

Table 5. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 5 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
11. Stream C and D interim storage tanks, pump station and force main to mid-canyon (Appendix A.15)	424	151	0-10	1,712	1,485	1,352
12. Addition to and expansion of the existing pretreatment plant to accommodate Streams C and D treatment facilities in mid-canyon (flow volume approximately 1230 gpm)						
a) Flow equalization storage tanks, three 500,000-gal coated steel tanks with 36-hr detention (Appendix A.20)	420	21	0-10	599	567	549
b) Air stripping towers including vapor-phase activated carbon adsorption system for air-stripping tower exhaust (Appendix A.20)	915	509	0-10	5,257	4,490	4,043
c) Reverse osmosis system including mixed-media filtration (Appendix A.23)	3,385	992	0-10	11,847	10,352	9,480
d) Final treated effluent storage tanks, six 500,000-gal coated steel tanks, 72-hr detention (Appendix A.17)	840	42	0-10	1,198	1,135	1,098
e) General site start-up costs at 20 percent of Streams C and D treatment facility capital costs*	1,112	--	--	1,112	1,112	1,112
13. Treatment of Stream C (70 gpm) only, after Stream D extraction has been discontinued						
a) Flow equalization storage tanks	(see No. 12(a) above)	21	11-40	306	132	76
b) Air stripping and carbon adsorption of stripping exhaust	(see No. 12(b) above)	200	11-40	2,917	1,262	727
c) Reverse osmosis and mixed-media filtration	(see No. 12(b) above)	388	11-40	5,659	2,448	1,410

Table 5. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 5 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000)		
				3%	7%	10%
d) Final treated effluent storage tanks	(see No. 12(d) above)	42	11-40	613	265	153
14. Treated Streams C and D effluent gravity pipeline to community area (Zone 4) and lower canyon (Zone 3) and reinjection wells, including transport and reinjection (Appendix A.25)	1,535	326	0-10	4,316	3,825	3,538
15. Treated Steam C effluent transport to lower canyon area (Zone 3) and reinjection (Appendix A.25)	(see No. 14 above)	74	11-40	1,079	467	269
16. Treated Streams C and D effluent gravity pipeline to mid-canyon (Zone 2) reinjection wells, including transport and reinjection (Appendix A.25)	214	82	0-40	2,109	1,307	1,016
17. Testing of Streams C and D treated effluent prior to reinjection, 1 test per each million gal (two 500,00-gal tanks) (Appendix A.27)	--	410	0-10	3,497	2,880	2,519
18. Testing of Stream C treated effluent prior to reinjection after Stream D extraction has been discontinued, 1 test per each 500,000 gal (Appendix A.27)	--	46	11-40	671	290	167
19. Treated Stream A and B effluent and reverse osmosis brine storage tanks						
a) Streams A and B, two 100,000-gal coated steel tanks planned for construction at mid-canyon pretreatment plan (Appendix A.17)	120	6	0-63	289	205	180
b) Reverse osmosis brine, four 500,000-gal coated steel tanks (Appendix A.17)	560	28	0-40	1,207	933	834

Table 5. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 5 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
20. Force main and pump stations to transport treated Streams A and B, and revese osmosis brine from treatment of Streams C and D, from the mid-canyon to SARI (Appendix A.15)						
a) Stream A at 45 gpm, Stream B at 20 gpm, Streams C and D brine at 500 gpm	7,579	950	0-1	8,501	8,467	8,443
b) Stream A at 10 gpm, Stream B at 20 gpm, Streams C and D brine at 500 gpm		902	2-10	6,819	5,492	4,722
c) Stream A at 10 gpm, Stream B at 20 gpm, Stream C brine at 30 gpm		772	11-40	11,259	4,870	2,806
d) Stream A at 10 gpm, Stream B at 20 gpm		765	41-46	1,270	244	74
e) Stream A at 10 gpm		755	47-63	2,435	317	74
21. Disposal of treated Streams A and B and reverse osmosis brine (Streams C and D) to SARI (Appendix A.27)						
a) Flow rates same as 20(a); one analysis per 200,000 gal for A and B, one analysis per one million gal for C and D	--	3,299	0-1	3,876	3,731	3,629
b) Flow rates same as 20(b); analyses same as 21(a)	--	3,707	2-10	28,022	22,572	19,408
c) Flow rates same as 20(c), A and B analyses same as 21(a), one analysis per 500,000 gal for Stream C	--	825	11-40	12,032	5,204	2,998
d) Flow rates same as 20(d); A and B analysis same as 21(a)	--	558	41-46	927	178	54
e) Flow rates same as 20(e); one analysis per 200,000 gal	--	440	47-63	1,419	185	43

Table 5. Estimated Capital, Operation and Maintenance, and Present Worth Costs for Remedial Alternative No. 5 (Continued)

Description of Remedial Alternative Element	Estimated Capital Cost ($1000)	Estimated Annual O&M Cost ($1000)	Estimated Years O&M Incurred	Present Worth Cost (Capital plus O&M) ($1000) 3%	7%	10%
Subtotal	312,064	--	--	529,313	439,608	409,870
Bid Contingencies (15%)	46,810	--		46,810	46,810	46,810
Scope Contingencies (40%)	124,826	--		124,826	124,826	124,826
Subtotal	483,699	--				
Permitting and Legal (7%)	33,859	--		33,859	33,859	33,859
Services During Construction (8%)	38,696	--		38,696	38,696	38,696
Subtotal	556,254	--				
Engineering Design Cost (8%)	38,696	--		38,696	38,696	38,696
Total Capital Cost	594,950	--				
Total Present Worth				812,199	722,494	692,756

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* Includes contractor mobilization, bonding, and temporary facilities; general site work such as clearing, security fences, and grading; gravel and paving; buildings; and domestic water system. No land purchases are included.

**Forseeable future

Present worth costs are impacted overwhelmingly by the expense of onsite soil incineration and chemical stabilization. Treatment of Stream C and D, and transport and discharge of effluent to the SARI line, are not weighted as heavily in the total present worth costs as in other remedial alternatives.

Lower Canyon Plume Cleanup

All remedial alternatives include installation and operation of an extraction well barrier in the lower canyon area north of Highway 60 at the south end of Zone 3. The purpose of the well barrier is to intercept the contaminated groundwater plume to prevent further contamination of groundwater resources in the community area south of Highway 60. This well system is an early implementation action that was formally approved in June 1987 by DHS and EPA as an essential component of the final remedy selected for site and community cleanup. Construction is expected to begin later this year and be completed in 1989.

Currently, the project involves construction of at least five extraction wells. Captured groundwater (Stream C) will be temporarily stored in tanks near the wells, then pumped through a pipeline to the Stringfellow pretreatment plant. Organic contaminants include TCE and chloroform while inorganic contaminants consist of nitrates and sulfates. Contaminated groundwater will be treated separately but in the same vicinity with Streams A and B. Treated groundwater will be placed in new storage tanks and discharged to the SARI line.

In addition to the extraction wells, observation wells will be installed to obtain water level measurements and samples to monitor chemical characteristics of the plume. Monitoring will provide data on subsurface conditions in the alluvium, decomposed granite and bedrock aquifers directly north and south of the well barrier. This information will be used to make the extraction barrier as efficient as possible.

When the final remedy is selected, variations for Stream C treatment and disposal could occur. Stream C may be combined with contaminated groundwater extracted from the community (Stream D). Treatment is detailed in the next section. Also, a system of reinjection wells may be added to Zone 3 to accelerate cleanup of the contaminant plume in the lower canyon. Reinjection wells would be supplemented with a few additional extraction wells placed near the middle of the lower canyon area.

Community Plume Cleanup

DHS and EPA formally proposed a cleanup plan for site-related contaminated groundwater south of Highway 60 in Glen Avon. The proposed plan calls for implementation of groundwater extraction, treatment, and reinjection into the community aquifer. The objective is to reclaim the aquifer so community groundwater can be made available for public use as a drinking water supply. This plan would require installation of extraction and reinjection wells in the community, design and construction of a new treatment plant adjacent to the existing mid-canyon pretreatment plant, and installation of storage tanks, piping, and monitoring equipment.

The proposed plan was released June 30, 1988 for public review and comment and the June/July issue of the Stringfellow Update newsletter detailed the joint DHS/EPA recommendation. The public comment period for the proposed plan and the FS Report closes September 30, 1988.

The plan calls for extraction wells to be placed along the centerline of the plume south of Highway 60. As contaminated groundwater is extracted, clean groundwater from surrounding areas would flow into the plume, reducing contamination levels. Reinjection wells installed at the sides of the plume would pump treated water back into the aquifer, accelerating plume cleanup. The system would operate until groundwater within the plume achieves federal drinking water standards and the drinking water specifications developed for underground water basins by the Santa Ana Regional Water Quality Control Board, the state agency that establishes standards for reinjection and underground water supplies.

Groundwater would undergo air stripping treatment to remove TCE and chloroform, the two site-related organic chemicals that exceed state drinking water guidelines. This treatment process would also reduce concentrations of other organics that do not exceed any drinking water standards. To meet air quality standards, the air stripping unit will have a multi-stage activated carbon emissions control unit with in-line monitoring and an automatic shutdown device if air quality standards are exceeded.

After air stripping, mixed media filtration using a sand filter combined with a charcoal-type filter would remove suspended solids from the treated water. Next, reverse osmosis treatment would remove inorganic sulfate and nitrate compounds from pretreated water. A backwash stream estimated at 40 percent of the water that enters the reverse osmosis system would be produced. Backwash water would meet discharge requirements of the SARI industrial sewer line. If SARI disposal is not available, mechanical reduction could reduce this stream to a manageable amount that could be treated at the existing pretreatment plant.

Cost Comparisons

Tables 6, 7, and 8 present summaries of the estimated capital, O&M, and present worth costs at three discount rates for the basic remedial alternatives previously described. The itemized costs and descriptions of these cost elements can be found in Tables 1 through 5. There is essentially no cost associated with the No-Action Alternative (remedial alternative No. 1); it is shown for reference only. It is clear based on total present worth costs that the remedial alternatives become progressively more costly going from No. 1 to No. 5, a function of both capital and O&M expenditures. The large total present worth cost increases for remedial alternative No. 4B and remedial alternative No. 5, reflected in their capital and contingencies costs, are due to contaminated soil excavation, treatment, and disposal.

Short- and long-term O&M costs are presented in Tables 6, 7, and 8 in terms of present worth costs, to demonstrate the time relationship of expenditures. Using 7 and 10 percent discount rates, short- and long-term O&M costs are generally equivalent, depending on the remedial alternative. Using a 3 percent discount rate, however, long-term O&M costs are at least twice as costly as the short-term costs for all RAs.

Table 6. Remedial Alternative Present Worth Cost Estimates[1] -
3 Percent Discount Rate ($1000)

	Remedial Alternative					
	1	2	3	4A	4B	5
Capital[2]	--	25,920	28,398	38,920	130,020	312,064
Contingencies[3]	--	18,715	20,503	30,494	117,863	282,886
Operation and Maintenance[4]						
Short-term (0-10 yr)	--	63,575	68,533	77,178	82,550	68,533
Long-term (11th yr-forever)	--	118,420	175,958	186,793	173,522	148,716
TOTAL ALTERNATIVE COST	--	226,630	293,392	333,385	503,955	812,199

[1] See Tables 1 through 5 for descriptions of cost elements.

[2] All capital costs are incurred within first 10 years.

[3] Total based on percentages of capital costs as follows: bid 15%, scope 25-40% depending on remedial alternative, permitting and legal 7%, services during construction 8%, engineering design costs 8%. These contingencies were determined from the REM IV Cost Estimating Guide.

[4] Present worth costs of operation and maintenance, labor, power, chemicals, parts and equipment replacement, monitoring, etc.

These short- and long-term time periods were arbitrarily chosen to allow general comparisons of O&M expenditures over the remedial alternative lifetimes. The costs shown approximate the O&M expenditures over these time periods.

Table 7. Remedial Alternative Present Worth Cost Estimates[1] - 7 Percent Discount Rate ($1000)

	Remedial Alternative					
	1	2	3	4A	4B	5
Capital[2]	--	25,920	28,398	38,920	130,020	312,064
Contingencies[3]	--	18,715	20,503	30,494	117,863	282,886
Operation and Maintenance[4]						
Short-term (0-10 yr)	--	52,345	57,120	64,965	69,492	57,120
Long-term (11th yr-forever)	--	47,607	71,692	82,873	75,296	70,424
TOTAL ALTERNATIVE COST	--	144,587	177,713	217,252	392,671	722,494

[1] See Tables 1 through 5 for descriptions of cost elements.

[2] All capital costs are incurred within first 10 years.

[3] Total based on percentages of capital costs as follows: bid 15%, scope 25-40% depending on remedial alternative, permitting and legal 7%, services during construction 8%, engineering design costs 8%. These contingencies were determined from the REM IV Cost Estimating Guide.

[4] Present worth costs of operation and maintenance, labor, power, chemicals, parts and equipment replacement, monitoring, etc.

These short- and long-term time periods were arbitrarily chosen to allow general comparisons of O&M expenditures over the remedial alternative lifetimes. The costs shown approximate the O&M expenditures over these time periods.

Table 8. Remedial Alternative Present Worth Cost Estimates[1] - 10 Percent Discount Rate ($1000)

	Remedial Alternative					
	1	2	3	4A	4B	5
Capital[2]	--	25,920	28,398	38,920	130,020	312,064
Contingencies[3]	--	18,715	20,503	30,494	117,863	282,886
Operation and Maintenance[4]						
Short-term (0-10 yr)	--	45,794	50,488	47,764	61,764	40,438
Long-term (11th yr-forever)	--	31,030	47,507	63,243	46,847	57,368
TOTAL ALTERNATIVE COST	--	121,459	146,896	180,421	356,494	692,756

[1] See Tables 1 through 5 for descriptions of cost elements.

[2] All capital costs are incurred within first 10 years.

[3] Total based on percentages of capital costs as follows: bid 15%, scope 25-40% depending on remedial alternative, permitting and legal 7%, services during construction 8%, engineering design costs 8%. These contingencies were determined from the REM IV Cost Estimating Guide.

[4] Present worth costs of operation and maintenance, labor, power, chemicals, parts and equipment replacement, monitoring, etc.

These short- and long-term time periods were arbitrarily chosen to allow general comparisons of O&M expenditures over the remedial alternative lifetimes. The costs shsown approximate the O&M expenditures over these time periods.

For purpose of easy reference, Table 9 presents a summary of the total present worth costs for the basic remedial alternatives.

Table 9. Estimated Total Present Worth Costs for the Basic Remedial Action Alternatives

Remedial Alternative Number	Total Present Worth* ($1000)		
	3%	7%	10%
1	--	--	--
2	226,630	144,587	121,459
3	293,392	177,713	146,896
4A	333,385	217,252	180,421
4B	503,955	392,671	356,494
5	812,119	722,494	692,756

*Includes total capital cost. Three discount rates were used to calculate present worth for each alternative.

Mr. **Brown**. Mr. Scheuer, any questions?

Mr. **Scheuer**. No questions.

Mr. **Brown**. Mr. Presley?

Senator **Presley**. I guess number 5 would be the optimum, that would be the best you could do under the present technology for total cleanup, your number 5 alternative here?

Mr. **Petrilli**. Well, it—

Senator **Presley**. I think that is what you described on your—this one right here.

Mr. **Petrilli**. In terms of—

Senator **Presley**. That says all excavation operations.

MR. **Petrilli**. What total excavation does—

Senator **Presley**. What I am getting at though, is that the ultimate cleanup?

Mr. **Petrilli**. It depends on the point of view.

Senator **Presley**. That is the best you have to offer?

Mr. **Petrilli**. No. I think all of them, when you compare them according to the various guidance documents, all have certain elements that are better than others. Total excavation for instance, although you are removing all of the contaminants, on the downside what you are doing, is digging up contaminants that are currently in the ground and increasing risks.

Senator **Presley**. I thought as you were going through those alternatives, that when you were going from 1 through 5 and 5 being the most complete, most ultimate cleanup. That is not true?

Mr. **Petrilli**. That is not the way they work really. For instance the—

Senator **Presley**. How come that one costs more?

Mr. **Petrilli**. Because you are digging up a lot of soil and you are hauling it and it is a lot of—

Senator **Presley**. That would take sixty-three years and $595,000,000?

Mr. **Petrilli**. The cost of excavation. The cost of moving soil, you are doing it in a very—you are doing that in Level A, which means fully encapsulated suits and everything. It is not like just going in and digging for a highway.

You are also treating it, the treatment is an expensive cost, incineration in this case is what is used for that cost. You are also treating it after incineration to stabilize it, then you are hauling it again, you are hauling these millions of yards back again and filling the hole again, which has been lined with an artificial liner to help impede or retard groundwater from moving back in the site. It is a very costly option from that perspective.

Senator **Presley**. I am glad you cleared up the discount, I thought maybe it was on sale or something.

Mr. **Brown**. Mr. Clute.

Mr. **Clute**. Thank you, Congressman.

Let us talk a little bit more about incineration. Which of the alternatives would require incineration, in the alternatives?

Mr. **Petrilli**. Both Alternative 4B and 5. Anything that requires excavation. That is incineration.

The other treatment method that was introduced was soil washing, which is not an incineration technology.

Mr. **Clute**. The 4A would not require any incineration?

MR. PETRELLI. No.

Mr. CLUTE. Would you go more into detail of the incineration process in 4B and 5, please?

Mr. PETRILLI. In terms of the type of incinerator that was—

Mr. CLUTE. I am probably more concerned with the volume, what is going to be going into the air; the hours involved; the days involved.

Mr. PETRILLI. First of all, there were treatability studies done as part of the RI/FS. And one of the treatability studies which is a study that actually took soil from the Stringfellow site, sent this soil to several vendors to have them incinerate it, to just see what the capability was of the various type of incinerators that were used; how the air emissions were controlled, et cetera; and the cost, just how much does it cost to burn it.

From these treatability studies then, we were able to get a good idea of what incineration method worked best. As it turns out, a couple, as most of these technologies, have some positives and negatives associated with them.

In the cost estimate we have used a rotary kiln incinerator and infrared incinerator, both simultaneously and developed costs for both of those. Both have—would have to meet, although this is an on-site action and theoretically would not have to meet air pollution permit standards. If they do they meet the 99.999 percent destruction of the contaminants and beyond that you also have established air emission control systems which reduce it to zero emissions during the incineration process.

In terms of costs, right offhand, I do not know, I would have to look.

Mr. CLUTE. We have heard, I have heard, I know many people have heard in this area of different types of proposals in incineration and I am aware of some of the EPA criteria, but I am also aware that from a health standpoint, that despite the statistics that you are quoting, that really does not satisfy this area of what you are talking about putting into the air.

I guess what I am considering, especially for people living there, is it really viable, feasible and the right thing to do, to go from one toxic situation underground to another toxic situation in the air, as part of this cleanup and as part of the solution. Have you really considered that scenario and how serious are you really about incineration in this area?

Mr. PETRILLI. All of the alternatives underwent a risk analysis and what the risk analysis did, I am not a risk expert, but we have toxicologists and people that look at, during excavation, just what is emitted by modeling in the air when you are digging this stuff up; what is moving. When you are incinerating it, what is leaving the site. And it must meet certain criteria, it must meet the 10-6 Criteria, for instance, before it can be legally or theoretically okayed as a potential technology. Yes, those things were looked at.

And our general—this is not an incinerator in the sense of a eighty-foot stack with smoke and so forth gushing out of it. When people hear the word incineration, a term they like to use nowadays is thermal destruction, that is what people like to use. It is a much different type situation. You can control those—what is being emitted. MR. Clute. Well, incineration sites in general, have been defeated in places in this state all over the place and I know many times the advocates will state some of the things that you just stated as far as the safety of them. But I do not think that people in general are ready to accept on a broad basis incineration, because it is going to be safe with our environment and with our health. And I know what Congressman Brown asked earlier to Mr. Cunningham, is that other alternatives be considered. And I would say especially in regard to incineration, that other alternatives be really, seriously considered.

Ms. **Meyer**. Mr. Clute, I think you are reading a little bit too much into it. Incineration was identified as a technically viable option, but there are other options also proposed to address the organic content of the materials in the waste. There is only one percent organic content in that waste and that is what the consideration technology was aimed at. There are other technologies posed in the Feasibility Study that could do the same job that incineration does for a lesser amount of money and that is why we did present an array of options. We are not pushing incineration.

Mr. **Brown**. Let me follow up on that a little bit, if I may. You made the statement that a thermal destruction process was to avoid incineration, would be such that there would be no observable, no detectable emission sent into the atmosphere.

Mr. **Petrilli**. Based on the treatability studies that we have done and Assemblyman Clute is right, the vendors will tell you no, there will be nothing coming out of that if you put the proper air control mechanisms on the system.

Any system though, then will require constant monitoring, because anything we build can break, and when this occurs then you have to shut the system down, retool it to make it work better. That is why incineration has its problems in being—having reliability problems in making sure the thing is running continuously. And what you are talking about operating here, is a continuous operation for I believe it is five years and maintaining that system for five years. So that is something you have to consider.

Mr. **Brown**. All right, but even if it works perfectly, you are only talking about that one percent of the waste which are volatiles, organics. With regard to the process of excavation, do your studies reveal how much of these volatiles or organics sublimate into the atmosphere during the process of excavation and hauling?

Mr. **Petrilli**. During one of the treatability studies for incineration, we had to excavate soil on site and we did some soil gas work there trying to get some readings on just kind of an aside study to see what we could find out. I think what you are going to find, what we have found, is during the excavation, a lot of these things will just volatilize by just moving the soils around.

Mr. **Brown**. For all the money you have been paid you should know how much of it volatilizes.

Mr. **Petrilli**. Well, our assumption is all of it will, just in moving the soil. You are talking about moving millions and millions of yards.

Mr. **Brown**. Why do you need to treat it with thermal destruction if you haul—

Mr. **Petrilli**. Well, then you have the non-volatile organics that are still in the soil.

Mr. **Brown**. How much are those? What percentage?

Mr. **Petrilli**. I do not know right offhand, sir.

Mr. **Brown**. How about the heavy metal?

Mr. **Petrilli**. The heavy metals would not be affected by incineration and that is why you go from an incineration to a stabilization process after that to tie up those metals before redisposal.

Mr. **Brown**. Do any of you know the relative percentage of these various toxic components? Volatiles, non-volatiles, heavy metals.

Remember, we expect you to know everything for all the money that has been put into this.

Ms. **Meyer**. I think it is somewhere.

[Pause.]

Mr. **Brown**. All right, just tell me it is in the book someplace, we do not really need it.

Mr. **Petrilli**. Okay.

Mr. **Brown**. It is in the book?

Mr. **Petrilli**. It is in the book. It is either in Appendix A, which talks about the—it is in both studies.

MR. **Clute**. May I ask him one more, Congressman?

Mr. **Brown**. Mr. Clute.

Mr. **Clute**. And I know Ms. Newman is going to talk about this later, but I did want to bring up one point that she is going to bring up and it states in Alternative 5, which apparently does have some definite support, but that it limits treatment to, at least part of it, to incineration and for some reason other technologies were not explored with 5, other than incineration. And I just wondered why.

Mr. **Petrilli**. Well, soil washing is included in the Feasibility Study. It was one of the later technologies introduced. In fact it was introduced about three weeks prior to the issuance of the study itself. It was introduced, and you can find it in Appendix A, it is one of the treatment technologies shown, I think it is 31 or 32 in there.

It is also mentioned in—a number of these alternatives will have subdecisions associated with them. One of the subdecisions is whether to use extraction wells or the tunnel.

There are subdecisions on how to treat the water, using carbon or air stripping.

Another subdecision is whether to use incineration or soil washing. This is by no means a designed document; they are not going to take this in the field and start building this stuff. There will have to be a decision made at the time if you choose to excavate and treat, whether you want to use soil washing or incineration.

For the costing, we use incineration because we had done a lot more work on that in the past year, whereas soil washing came in at the tail end. But it is in the study.

Mr. **Brown**. All right.

Just looking at it from a lay perspective, we want to make sure that every feasible technology is given every reasonable consideration. Just because you did not have time enough to finish it, complete consideration does not mean it should be ruled out of consideration, but additional data indicates it is worthwhile; is that unreasonable?

Mr. **Petrilli**. I am just a consultant. But in terms of the whole study, if you are looking at a ten-year operation, there are going to be plenty of technologies that are going to come in along the way that no one has even thought of yet. I think those should be considered as well, as we move through cleanup.

Mr. **Brown**. Well, the only way we are ever going to get our money back from this is to learn something from it. In other words, we have got to learn from the practical experience of correcting this problem, how to correct a million more around the country, and then we can amortize the $800,000,000 or whatever it costs us to get this information.

I get a little testy sometimes here, because you know, I have been living with this problem for sixteen years, efforts to solve it for ten years. The only people that are getting any money out of it are you guys; the rest of us are sitting here taking the heat. And it is something that will make you testy after awhile. It could be my age, but then sixty-eight years of this will age anybody.

Any other questions of this panel? If not, thank you very much. You have done an excellent job, you have produced lots of information, thoroughly confused us all.

Our next witness will be Mr. Jeff Zelikson of the U.S. Environmental Protection Agency, Region 9. Mr. Zelikson.

All right, Mr. Zelikson, the EPA of course is not without fault in all of this and we will allow you to explain why you have done what you have done and why you did not do it better.

STATEMENT OF JEFF ZELIKSON, DIRECTOR, TOXICS AND WASTE MANAGEMENT DIVISION

Mr. **Zelikson**. Okay, thank you.

I will attempt to make my presentation both interesting by not reading it, since you have it in front of you, and make it short by referring to only portions of it, again because you have the full testimony in front of you.

I would say welcome and good morning to all of you, particularly Congressman Scheuer, because six years ago I came to visit a friend here in California and decided to stay from New York and took a one-way ticket.

After we got all those problems in New York and New Jersey cleaned up we figured we would come out here and take care of a few.

I have been involved with this site for most of those years that I have been out here in one way or another. The prime focus of my testimony is going to be how to take all of these volumes of information that we have and how do we sort that out and make a decision about it. I will highlight the nine criteria that have been mentioned before, but in a bit more detail.

Before I do that though, and I think it is important and Congressman Brown I think you have indicated some frustration about wanting to learn from what we do here at Stringfellow to help us deal with sites, both in California and the rest of the country, and I could not agree more.

One real benefit that we have at this site is that we have in fact spent some of all that money to actually do some good. We have contained this problem to a large extent and with the proposal that we have in front of the community now to deal with the contamination of the groundwater in the community, it is kind of the last piece of a containment of this problem and to some extent that does give us the luxury of time to look at a full range of options for the final remedy here and perhaps to explore some new technologies to be sure that we are in fact getting the most for our money. But I would say that, I know you have been out to the site, that there actually is some hardware, we have some sophisticated paper analysis, but we do have some hardware out at that site. That we have drilled a lot of wells, again it is not just paper, it is real physical structures out there.

The treatment plant is one number that I think is significant, it costs us $5,000,000 a year to operate and that has been operating for a number of years, and that is doing some real good. So there is some, I think, very tangible things that we can look to and actually touch that we have accomplished here at this site.

Let me say again, just to highlight these nine key criteria, and highlight what they are. These basically are identified in the Superfund statute and include the following:

One—there is really two that I would say that all remedies need to meet, and that is they need to be protective of human health and the environment and they have to be able to meet all the relevant federal and state standards. So there is not any remedy that could even get the full blown analysis done on it unless we make a decision and in fact it meets those two important criteria. So, I think, Senator Presley, you were concerned, well, is that the most extensive—every one of the options in here meets those two criteria. Will all options protect public health and will in fact meet all of the appropriate standards?

Then it gets more complicated, which is to look at a whole bunch of other criteria which we use to balance and evaluate the various options against. And those criteria include things like long-term effectiveness and permanence, and we are going to hear more about that later.

Reduction of toxicity mobility and volume, short-term effectiveness, implementability and cost are those I would say are, in terms of the more objective fact, is that the engineering folks would go through and highlight in these reports, would be the next kind of phase of criteria that we would look at. But then once that is done and we are in the place that we are in now, we have got all of those options arrayed, we need to get input from elected officials from the community, from all the various agencies that have something to say about how this cleanup is to go and therefore, community acceptance and state and other agency acceptance become the last two of the nine criteria.

Let me just say a bit more about each of these criteria before we open it up for questions. Protection of human health and the environment, as I mentioned before, all remedies must meet these. The kinds of issues that get addressed in looking at those, include things like: The risk assessment that was referred to before, looking at both short-term risks, risks for example that Assemblyman Clute was referring to, like what is the short-term risk of actually the remedy itself, incineration or whatever; excavation of the material.

We also look at the long-term risk. What are we going to do that is going to make this site not come back and haunt us in the future. So long-term risks are also important.

We look at the various constituents in the site reduced to the extent that it is practical and possible, the toxicity, mobility and propensity to bioaccumulate of any of these hazardous materials.

In terms of the second criteria, which is what we call ARARS, you might hear that. It means applicable or relevant and appropriate standards. Basically, in the lay language, it means everything and anybody we could think of that we want to consider here, ought to be considered. And that is an important piece of the new Superfund, which really what it does is it raises to the same level of importance as the federal standards, all of the state standards and here in California I can tell you that that is very important. Because there is a very active legislature that has some definite ideas about how the environment is to be taken care of here. So meeting those state standards is a requirement and very important.

Short-term effectiveness looks at things like reducing the risks in the short term, particularly with respect to the workers that might be at the site or risks to the community during the course of the cleanup itself.

Long-term effectiveness again, is then looking at the long- term problem and how much we can reduce the risk there.

Toxicity, mobility and volume, I think that that was pretty well explained before.

The sixth one, implementability, is the ease or difficulty of implementing any of the alternatives and things like how difficult is it to construct the technology, how reliable would it be, can you get the necessary permits. If for example, we were planning on moving this material to another location, is that a possibility, those kinds of things would be looked at.

I think also in terms of implementability, and it comes together with the issue of state acceptance, is the question of availability of funds, and in Mr. Cunningham's statement he raised some issues there that would be of concern to the state legislature about making sure that the state is able to come up with its share of any of the cleanup funds that are necessary for the site, and that would certainly affect implementability of any of the options.

Cost is certainly a factor, and I think that while we would like to have an endless supply of money for all of these sites, that just is not the way it is, so cost is definitely a consideration and the balancing of the costs against these other criteria is something that we will have to do in the final analysis in making this decision.

And then community and state acceptance are the eighth and ninth, again, criteria. And public involvement has been and will continue to be an essential element in the selection process.

One of the things that we did here at Stringfellow was to fund a scientific consultant for the community and it actually served as a model for the legislation that has enabled that. That is one of the things I think Congressman Brown, we can say we have learned here, that that has been a helpful thing at Stringfellow. We have learned from that and applied it to other sites through the legislation.

But all nine criteria will certainly be important. It is going to be a difficult decision. We know that the community will be working with us on that and we look forward to making a decision that most people will feel good about.

Let me just say in conclusion that much investigative work has been done at this site. We have in fact contained the groundwater plume from the site. Immediate public health concerns, I am thankful to say, have been essentially mitigated at this time and that the decision on the final remedy at Stringfellow will not be an easy one. These nine criteria tend to compete, one with another, and it will be a difficult decision.

I certainly welcome the opportunity to be here and to help add to the process and hopefully we can have a better understanding of where we are going and how quickly we can get there as a result. So I would be happy to answer any of your questions.

[The prepared statement of Mr. Zelikson follows:]

TESTIMONY OF
JEFF ZELIKSON
DIRECTOR, TOXICS & WASTE MANAGEMENT DIVISION

BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL RESEARCH,
AND ENVIRONMENT
AND THE CALIFORNIA STATE SENATE COMMITTEE ON APPROPRIATIONS

SEPTEMBER 10, 1988
GLEN AVON, CALIFORNIA

Good morning Mr. Chairman and members of the respective committees. I am Jeff Zelikson, Director of the Toxics and Waste Management Division in EPA's San Francisco Regional Office. My responsibilities cover EPA's activities at the Stringfellow Superfund site.

I am pleased that you are holding this joint Federal/State hearing on Stringfellow at this point in the process. As you know, we are actively encouraging public participation in consideration of the Feasibility Study for remediation of the site; the public comment period is open until October 30. Your hearing will help us to solicit comments, to focus a dialogue on the alternatives, and ultimately to increase public awareness. As requested, I will focus my comments on the criteria EPA uses in the decision making process for the selection of a final remedy.

The Stringfellow site has long been recognized as a significant threat to public health and the environment, based on the amount and type of hazardous waste disposed at the site. It was therefore proposed for the National Priorities List, EPA's list for Superfund clean-ups, in 1981. EPA has assigned to the California Department of Health Services the lead responsibility for site management, which includes investigating, designing, and implementing remedies. Since 1981, EPA has provided almost $30 million to the State for construction projects, site maintenance, ground-water sampling, and the investigations and studies which have led us to the current consideration of final remedial alternatives. In addition, EPA has spent approximately $15 million on emergency maintenance and preventative measures, enforcement, treatability studies; and most importantly, the construction, oversight, and operation of the treatment plant which currently treats contaminated groundwater pumped from the site and the mid-canyon area. The Agency has spent a total of approximately $45 million on the site so far. As a result of these efforts, we believe the imminent danger of releases from the site has been mitigated; the site has been stabilized and contained; and the risks to the community of Glen Avon have been dramatically reduced.

One of the key tasks managed by the State has been the preparation of the Feasability Study currently undergoing public comment. There are two parts to that study. The first part serves as the basis for the continuing program to extract and treat groundwater from the areas downgradient of the site, specifically those areas within the community of Glen Avon. This project is the next component of the groundwater extraction and treatment program already underway above the freeway. This new "community well" system would capture contaminated ground water that has traveled beyond the currently operating extraction wells and thereby provide additional containment of plume migration and additional protection of the community.

The second part of the Feasibility Study summarizes the alternatives being considered for final remediation of the entire site. It is important to note that the agencies have not proposed any one of the final remedies, but rather are taking comments, which will then be evaluated in our decision-making process. It is also important to distinguish this from the community well system where the agencies have a specific proposal to implement and are taking comments on that proposal. We are encouraging public comment on both the community well system and on the information presented for each final remedial alternative. Later this year, a specific proposal will be issued to address the final remedy for the site, and a second comment period will be initiated.

The decisions will all be made jointly with the California Department of Health Services to avoid public confusion caused by multiple agency actions.

In summary, with respect to the community well system, a final decision will be made following consideration of comments on that proposal. For the community well system remedy selection, we are procedurally a step ahead of final remedy selection in that a proposed plan has already been released for the community wells. However, EPA's decision process is the same for the community well system as well as the final remedy. It includes public participation, a formal proposed plan with alternatives identified, a public comment period including a public meeting, preparation of a responsiveness summary, and full consideration of comments.

The remainder of my testimony addresses the criteria EPA will use in making these decisions. As you may know, the remedial decision is formally incorporated into a Record of Decision (ROD) to be signed by the Regional Administrator.

During the Feasibility Study analysis, EPA assesses the individual alternatives against nine key criteria, based on the statutory language of CERCLA* Section 121, and then further assesses the relative strengths of the alternatives against each other. That is, the advantages and disadvantages or tradeoffs for each are compared.

EPA has identified nine cleanup criteria from the Superfund statute. These nine criteria can be categorized into three groups, each with distinct functions in selecting the remedy. During the selection process, the decisionmaker will consider these criteria as follows. Overall protection of human health and the environment and compliance with applicable or relevant and appropriate requirements (or invoking a waiver) are threshold criteria that must be satisfied in order for an alternative to be eligible for selection. Long-term effectiveness and permanence, reduction of toxicity, mobility, or volume, short-term effectiveness, implementability, and cost are the primary balancing factors used to weigh major trade-offs between alternative hazardous waste management strategies. State and community acceptance are modifying considerations that are formally taken into account after public comment is received on the proposed plan.

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* The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (CERCLA), 42 U.S.C. Section 9601, _et seq._

II. Description of Criteria

A. Threshold Criteria

1) Protection of Human Health and the Environment

According to CERCLA Section 121(b)(1), the remedy must be protective of human health and the environment. Issues that are addressed in the evaluation of this criterion should include the short- and long-term potential for adverse health effects from human exposure; the persistence, toxicity, mobility, and propensity to bioaccumulate of hazardous substances; the potential threat to human health and the environment associated with excavation, transportation, and redisposal, or containment. The remedial alternatives are thus assessed for protection of human health and the environment through consideration of many of the other criteria outlined here.

2) ARARs

CERCLA Section 121(d)(2)(A) identifies as potentially applicable or relevant and appropriate requirement (ARAR):

- any standard, requirement, criteria, or limitation under any Federal environmental law (e.g., Safe Drinking Water Act; Clean Air Act; Clean Water Act; Toxic Substances Control Act; Solid Waste Disposal Act; or Marine Protection, Research and Sanctuaries Act), or

- any promulgated standard, requirement, criteria, or limitation under a State environmental or facility siting law that is more stringent than any Federal standard, requirement, criteria, or limitation.

Section 121(d) specifically mandates the attainment of ARARs by the selected remedy. In assessing the attainment of ARARs, the following are given consideration:

- Contaminant-specific ARARs (e.g., Maximum Contaminant Levels and State Action Levels)
- Location-specific ARARs (e.g., historic preservation sites)
- Action-specific ARARs (e.g., Resource Conservation and Recovery Act (RCRA) requirements for incinerators and closure).

Section 121(d)(4) provides six waivers for situations in which all ARARs cannot be met. The circumstances under which ARARs may be waived are: fund-balancing, technical impracticability, interim remedy, greater risk to health and the environment, equivalent standard of performance, and inconsistent application of State standards. Use of any waivers must be justified in the ROD.

B. Primary Balancing Criteria

3) Short-Term Effectiveness

In assessing short-term effectiveness, the reduction of existing risk should be considered, along with the risks posed to the community, workers, and the environment during implementation. Also to be considered is the amount of time it will take before full protection is achieved.

4) Long-Term Effectiveness

Long-term effectiveness should be evaluated from the standpoint of whether human health and the environment will be protected after response objectives have been met. This would involve consideration of the magnitude of total residual risk and the adequacy, suitability, and reliability of engineering and administrative controls over time.

5) Toxicity, Mobility, and Volume

Remedies that involve permanent and significant reduction of the toxicity, mobility, and volume (TMV) of hazardous materials as a principal element are to be preferred over remedies that do not involve such treatment. TMV should be evaluated by considering the amount of hazardous material that is destroyed or treated, the degree of reduction of mobility or toxicity of the material, the degree to which the treatment is irreversible, and the residuals that will remain following treatment.

6) Implementability

Implementability is the ease or difficulty of implementing the alternatives and should be assessed by considering the degree of difficulty associated with constructing the technology, operational reliability, and the ability to obtain necessary permits and approvals from other offices and agencies (e.g., NPDES permits under the Clean Water Act). Also, the availability of services and materials, such as treatment, storage or disposal capacity, must be considered.

7) Cost Effectiveness

The various costs that are evaluated include capital costs, operation and maintenance costs, net present value of capital and operation and maintenance costs, potential future remedial action costs, and, where required, the cost of 5-year reviews.

C. Modifying Criteria

8) State Acceptance

State or other support agency acceptance is considered since States are joint risk managers with EPA in Superfund projects. In addition, states are required by CERCLA to operate and maintain the remedy. California Department of Health Services has been the lead agency on the Stringfellow RI/FS and has shared in the cost of activities at the site. Integral to EPA's remedy selection process is consideration of the State's comments on the various alternatives.

9) Community Acceptance

Public involvement is extremely important in the selection process. Public comment is formally solicited during comment periods following the release of the RI and the FS and Proposed Plan. At the Stringfellow site, public involvement has been strongly encouraged and supported by a very aggressive Community Relations Plan. Remedy selection involves evaluating the communities' comments on the various components of alternatives under consideration.

III. Record of Decision

Following the public comment period on the Proposed Plan, a responsiveness summary is prepared by EPA or the lead agency to address all of the comments received. The responsiveness summary is attached to the Final Feasibility Study Report. Any new information from the comments and summary is considered, and the remedy is then selected.

The ROD identifies the selected remedy, states the level of protection to be attained and rationale for it, and states the specific points of compliance, as appropriate (e.g., "Maximum

Contaminant Levels will be met at the edge of waste management area which is also one of the boundaries of the area of attainment for the groundwater").

CERCLA mandates that the remedy meet four statutory requirements:
1) That the remedy is protective of human health and the environment;
2) That the remedy attains ARARs or provides the grounds for invoking one of the six waivers provided for in SARA;
3) That the remedy is cost-effective;
4) That the remedy utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.
If EPA selects a remedial alternative that does not meet the preference for permanent solutions and alternative treatment technologies, the ROD must also explain why the preferences were not met.

In conclusion, let me emphasize that much investigative and remedial work has been done on the site. Immediate public health concerns have been mitigated at the same time that data collection has been ongoing. The decision on the final remedy for the Stringfellow site will not be an easy one. The 9 criteria tend to compete with one another. It is possible that not all of them will support any one alternative and that a balance will have to be achieved.

EPA welcomes comments and concerns which will help us in this evaluation process. Speakers to follow me will focus on the specific alternatives being considered, but I would be happy to take any questions you may have on EPA's process or the criteria we will use in making the decision.

Thank you.

Mr. **Brown**. Thank you, Mr. Zelikson.

Mr. Scheuer, do you have any questions?

Mr. **Scheuer**. Yes, Mr. Chairman.

Mr. Zelikson, you made a very thoughtful presentation of these nine criteria, these nine options. We understand that you, in the process of revising a national contingency plan, and we understand that the OMB has brought up the concept that in evaluating all of these, that short-term costs be given a greater priority over long-term effectiveness, over the long-term solution.

Can you tell us how these brilliant insights from OMB are reflecting themselves and what—and how EPA is going to factor them into the decision making process.

Mr. **Zelikson**. Yeah, I think—well, I can tell you that so far they have not had any impact at all. I mean, the draft contingency plan that you referred to, part of that process gets OMB approval and it is over in OMB and this dialogue about which of these nine criteria are to be more or less important, is in fact taking place. Interestingly enough—

Mr. **Scheuer**. And how have you heard from OMB?

Mr. **Zelikson**. I tell you, it is interesting because it was directly related to my appearance here today, because as you probably know, OMB has to sign off on testimony before congressional committees. We prepared the testimony, laid out the nine criteria and laid out exactly how we use them, which is to look at them all, and they all basically have equal weight. In the process of getting that endorsed by OMB, there was an active dialogue about what in fact we should be saying here. What I should be saying here actually. But I am happy to say that what I say here came about as a result of an agreement with OMB that in fact the criteria as I outlined, which is that they all are looked at with equal weight, is the way this thing I think is going to hit the street as a draft for thOnly hope so.

I would personally strongly disagree with an emphasis on short-term cost—

Mr. **Scheuer**. You disagree with what?

Mr. **Zelikson**. I would disagree with emphasizing, over-emphasizing short-term costs as one of the criteria.

Mr. **Scheuer**. Have they indicated to you that that is the way they perceive it?

Mr. **Zelikson**. I have not heard that personally, but I have probably heard the same thing you have, that at least that has been part of the dialogue that they have had with the agency administration back in Washington.

I think they are losing that battle, because it is a losing battle, ultimately, frankly. I think if for any reason something other than an equal balancing of those nine criteria would in fact hit the street in a draft, it would not stand the onslaught of public resistance to it, so I think it would be foolish for OMB to put either this administration or the next into that kind of predicament. So I hope that that reason will prevail.

Mr. **Scheuer**. As far as you are concerned, you do not feel there is any need to hoist the early warning signal in terms of OMB pressuring you really to distort the rational evaluation of the options.

Mr. **Zelikson**. Well, since—

Mr. **Scheuer**. Giving them a clean bill of health?

Mr. **Zelikson**. No. I would not say that. I say I think that they probably need all the pressure on them that they can have.

Mr. **Scheuer**. Good. You have given us a very clear signal.

Mr. **Brown**. Senator Presley.

Senator **Presley**. I want to make sure I heard you correctly. I think I heard you say that the present site in your opinion is contained and safe to the community, did you say?

Mr. **Zelikson**. Well, you know, I—yeah, I would say it is nothing absolute, but I think we are in pretty good shape at this site. I mean, there is a long history of not being in shape, but I am happy to be the witness here today than the witness that was here five years ago, for example, because I think we can step back and take time to look at what we really want to do here for the long term, knowing that nobody is drinking contaminated water, there is not material spilling over on the surface, and yeah, I think the site is reasonably contained.

I think that the last piece of that, the last pieces of it are going into place; the midcanyon and lower canyon extraction systems and then now with the advance of the community well project, I think that that really is the final piece of containing this plume.

Now that has an impact even on communities outside of Glen Avon, because part of the reason for that final containment is to prevent the contamination from moving into other communities.

So I say, you know, it has been a long, hard road, but I think we are in a pretty good place right now.

Senator **Presley**. so the progress that has been up to this point is that the problem has been contained, the plume has been, what, stopped, slowly.

Mr. **Zelikson**. I think—yeah, the plume is in the process of being stopped and again, with the implementation of the lower canyon system, well extraction system, which is in process, and with the decision on the community wells and then implementation of that, then we can say, yes, we have got all the containment pieces of this puzzle in place.

Senator **Presley**. So the Chino water basin should not be in danger?

Mr. **Zelikson**. That is our hope and objective, yes.

Senator **Presley**. Have you taken into consideration heavy rain, like has happened in the past, when you say what you just said?

Mr. **Zelikson**. In terms of surface runoff, yes.

Senator **Presley**. You think if we had heavy rains and the place filled up and the water flowing all over the place, that it would still be safe for the community?

Mr. **Zelikson**. I do not think, from what I understand about the cap and cover and the diversion structures around the site, that there should not be any contamination that would come from surface runoff from the Stringfellow into the community.

Senator **Presley**. Underground surface or—

Mr. **Zelikson**. And the underground materials, as I described, is being taken care of by these various extraction systems and by that treatment plant which we are operating at a cost of $5,000,000 a year now, which is basically dealing with the most concentrated leachate bits coming from the site.

Senator **Presley**. So if heavy rains started this winter, people could sleep reasonably well.

Mr. **Zelikson**. I think so.

Mr. **Brown**. That is exactly the line of questioning that I was ready to propound, Senator Presley, because I think the community does need reassurance.

Unfortunately, and I accept everything you said in good faith and I adhere to it, but that was the same testimony the previous witnesses years ago used to offer if they were asked with regard to the capping and other things that were done to protect the community at the time. And it proved out that they were not correct.

I think we are in a better position today. I hope that what you say is correct, but the possibility always exists, that if we have a combination of heavy rainstorms and an earthquake that comes right across there and that whole damn thing will spill out into the community again, for one reason or another. And we will say, well, we should have known, but this is an earthquake-prone region, and sometimes coincidences happen.

I am not saying this to frighten the community, I am just saying to indicate that we need to proceed aggressively with the final cleanup so that these things cannot happen.

Mr. Clute?

Mr. **Clute**. Thank you, and speaking of testimony five years ago, it apparently served one individual well, Mr. Thomas, because he went on and, I guess to lead your agency, because I can remember him five years ago. So maybe it is a good omen for you.

Mr. **Zelikson**. Yeah.

Mr. **Brown**. Do not count on it.

Mr. **Clute**. In your statements you mentioned that EPA guidelines and state guidelines would be followed in the alternative technologies involved. And I know it appears, it appears because it is true, that on focusing somewhat on incineration aspects, because I think five years of continuous incineration can have an awesome potential.

Mr. **Brown**. You would not like to use thermal destruction instead of incineration.

Mr. **Clute**. Is that better?

I think incineration describes to the general public what actually is going on, but I understand and appreciate there is much more to it and in this whole process, but because of those reasons I do want to be clear and I want to thoroughly understand that part of it. And so my question would be, I do believe the waivers would be provided by what, Southcoast Air Quality Management District in regards to incineration aspects?

Mr. **Zelikson**. Let us clarify that. I think there was something that was not actually clear before, and that is that because of the objective of trying to expedite cleanups at the Superfund sites, the law specifically says we do not have to get permits from various local and state agencies. But the law also makes it real clear, that we have to meet all of the standards.

So it says meet the substantive and technical requirements, but try to avoid the paper work so you can do it more quickly. So we will meet—if incineration were to be part of any of the solutions here, we would meet all the requirements of the local air district here.

Mr. Clute. So absence of permits does not mean absence of monitoring and very strict monitoring.

Mr. Zelikson. Right, correct.

Mr. Clute. Thank you.

Mr. Brown. All right, thank you very much, Mr. Zelikson. You have helped us understand the situation.

We are in a period now where we are going to have some opportunity for public comment in the public meeting, is that right?

Mr. Zelikson. Yes. In fact, we have extended the comment period to the end of October.

Mr. Brown. The end of October.

Mr. Zelikson. To be sure we have it all. And as we mentioned before, there is a September 20th public meeting and again we will have a lot of opportunity for that.

Mr. Brown. I understand you carefully selected that date because of the important Jewish holidays, is that right?

Mr. Zelikson. Oh, I did not know that, no.

Mr. Brown. Well, you might give consideration to it and think of an alternative date or subsequent date or an additional date or something like that.

Mr. Zelikson. Okay, sure.

Mr. Brown. Thank you very much for your testimony.

Next witness is Dr. Joel Hirschhorn, Senior Associate, Office of Technology Assessment on whom we have relied for assistance on this problem for all too many years and we are happy to welcome him here again to contribute his insight to the process.

Dr. Hirschhorn.

STATEMENT OF DR. JOEL S. HIRSCHHORN, SENIOR ASSOCIATE, OFFICE OF TECHNOLOGY ASSESSMENT

Mr. Hirschhorn. Thank you.

OTA appreciates the opportunity to be here today. Unfortunately there is a need to be here today.

I will just summarize briefly my written testimony and try to focus on what I think the real issues that are facing the people here.

First I would like to say that we have been working on hazardous waste cleanup problems since about 1980, when Superfund began, really. We have done a lot of work on individual sites, including a lot of work on Stringfellow.

In June we released our latest report on Superfund, entitled, Are We Cleaning Up? Ten Superfund case studies and I just would like to emphasize that one of the important findings of that recent report was that we are still using, choosing impermanent remedies for cleanup. The same kind of impermanent actions that really make Stringfellow a classic example of why we should not depend on containment and land disposal strategies to deal with hazardous waste, either when they are first created by industry and the government, or for cleanup.

There is in fact, an underutilization of advanced technologies. And I think where we are today at Stringfellow really is very interesting, because technologies have been moving very quickly. There is a lot of progress, the genius of American society which has been made reference to earlier, is definitely at work. The marketplace is a billion dollar—multi-billion dollar marketplace, it is attracting inventors and entrepreneurs and good scientists. But sadly, we are still not using the best technology to clean up toxic waste sites.

So here we are at an opportunity at Stringfellow finally, to consider using the best available cleanup technology.

What I would like to do is, just briefly give my opinion of the five alternatives which previous witnesses have described and which are in the Feasibility Study. I will give you my view of those alternatives and then I would like to offer four additional technologies that I think are worthy of consideration. And finally, and perhaps most importantly, I would like to lay out a possible scenario which I really think is a win/win situation to satisfy everyone that is concerned and interested in Stringfellow. How we could proceed from this date on.

First my comments on the alternatives that are in the Feasibility Study. Alternative 2, based on natural flushing essentially represents the mistakes of the past. This is no advance whatsoever; this is traditional containment in land disposal. It does not offer certainty with regard to a permanent remedy, so I essentially would dismiss that.

Alternative 3 is in fact, again, a pretty classic example of a containment approach and I think again, there is considerable uncertainty whether contaminated soil hazardous waste could be isolated completely from ground and surface water forever. So that is an alternative again, which does not satisfy the intent of the present Superfund law in terms of a desire to use permanently effective remedies for Superfund.

Alternative 4A, based on dewatering and soil gas extraction of volatile organics and in-situ flushing has some good points and particularly the best point about it, is in fact soil gas extraction of volatile organic chemicals.

However, the defect, essentially, in this alternative, is the in-situ flushing, which is just again, essentially passing water through a site in the hope that you will remove a lot of the contamination. I emphasize that this approach leaves again a lot of uncertainty because some contaminants, particularly some metals and some organics are not likely to be completely removed. So this alternative does not represent the kind of permanent remedy, good source control that we like to think of as the goal of the current Superfund statute. This is not proven technology. Even though in-situ flushing has been chosen for some Superfund cleanups by EPA, we have not seen any data today to indicate that this is again an effective, permanent remedy for complex Superfund sites and Stringfellow is very much a complex site in terms of the diversity of chemicals that contaminate the site.

Alternative 4B, has to do with selective excavation and treatment and also involves some soil gas extraction. Again, a good point. The problem with 4B, I think really, the basic point that I try to make in my testimony, is that although it seems sensible to excavate hot spots of contamination, the effectiveness of that approach really depends on how well you have done your monitoring, your site sampling. And I found it very interesting in reading the Feasibility Study, and that is a rather difficult document I might note to go through, might cost $10,000,000 or whatever, but it certainly is not a user/friendly document. Even a Ph.D does not help. Even ten years of experience in dealing with this situation does not help me in getting through that enormous amount of material.

But I did discover in reading that, that this particular alternative would only deal with about one-third of the total amount of heavily contaminated material at the site. So spending $357,000,000 to deal with one-third of the problem did not impress me as a particularly effective kind of remedy, nor a cost-effective remedy.

Now we get to Alternative 5. This is the one in which all diggable soil would be excavated and incinerated and then the residues chemically stabilized. Some talk has been made here that this alternative also considered soil washing. If it did consider it, it was in the most gratuitous way; the actual analysis to me, seemed to be based on incineration. Here the problems are the classic problems of concerns about incineration, concerns about an enormous amount of material to be excavated. And also I would emphasize in this case, really a valid concern is the use of chemical stabilization as the primary—excuse me, as the secondary treatment step. That adds a lot of movement of material.

This stabilization means mixing a lot of cement-like material with a very high volume of solid residue that would be left after incineration. Because only the small percent of organic material in the soil would be destroyed in the incineration, so you are left with a very high volume, a huge amount of solid material, which would then be mixed with a equal amount of cement-like material. So we are talking about an enormous transportation difficulty in moving trucks through the community and so on, to deal with this kind of approach, and ultimately it is a very expensive remedy.

We have to be concerned with cost, however, I would caution people in talking about cost-effectiveness, that the concept behind cost effectiveness is to deal with comparable environmental protection and pick the least costly remedy. People seemed to have lost that intellectual foundation for cost effectiveness and instead what we have drifted to, is a selection of the lowest cost remedy. And one of our findings in that recent June report we did on Superfund is again, you know, people ask me, well, why are we using impermanent remedies.

Well, the chief driving force in choosing impermanent remedies is the desire on the part of EPA, state agencies and responsible parties to find low-cost solutions. But the low-cost solutions usually selected do not offer comparable environmental protection to true destruction, permanent kinds of remedies for cleanup.

I think the interesting situation that I see now and after looking at these five alternatives, is to see this as an opportunity to seek a truly effective permanent remedy, based on the best technology, but which could be done at a cost of perhaps $100,000,000 to $200,000,000. I think that is the range of cost that ought to be seen as a reasonable cost objective for the Stringfellow site; one-hundred to $200,000,000, considering the complexity of the site, the volume of material that has to be dealt with.

And one of the things that I concluded after reading the Feasibility Study, is that they just have not done a good enough job on looking at the current state of cleanup technology. And again, that was one of our criticisms generally in the Superfund program.

Contractors implement most of Superfund. By the way, a lot of people do not know this, but nearly ninety percent of all the money appropriated for Superfund goes to contractors; just think about that. We are talking about billions of dollars that are going to these contractors.

And one of the interesting things is that the contractors that do these studies do not seem to be completely up to date on current state of technology. I also hear in the testimony four possibilities of cleanup technologies to be considered for Stringfellow.

The first is an advance form of chemical stabilization. It is interesting that this particular technology, which is again not a true destruction technology. I have to grant the fact that this technology is not destruction technology. But I want to preface my discussion of these four technologies with our view that we state at the end of the testimony, that the vacuum extraction of volatile organic chemicals is proven technology and could and probably should precede the use of any of these cleanup technologies or any of the alternatives that have been discussed in the Feasibility Study. So when I say that chemical stabilization, which is again, using a cement-like material, mixing it with the stuff at the site, remember that I am assuming that we could have removed the volatile organic chemicals prior to this.

This particular technology, by the way, has just been used at a major Superfund site in Florida, called the Pepper Steel and Alloy Site. It was approved and selected by the EPA. It cost less than $100 per cubic yard to clean up that site, and that site interestingly enough, was heavily contaminated with both organic and metal contaminants. It had heavy concentrations of PCBs, and enormously high concentrations of metals like lead. And it was approved by the government. It was rather low cost, less than $100 per cubic yard, believe me, a very low cost cleanup technology. It would lead to a total cost for Stringfellow in the range that I have indicated as a reasonable target range.

There are still lingering doubts about this technology. It has only been used once, still, I think worthy of further consideration.

The second technology I talk about is soil washing. There are different names used for this kind of generic technology, but basically the idea is to remove and separate and concentrate the contamination that exists within soil. It is not off-the-shelf technology. It has been tried a number of times already and it has failed a number of times. It is not easy to use this kind of technology when you have a lot of different kinds of contaminants, different kinds of organic chemicals, different kinds of metals. Still there are advances being made on this technology and it could be examined in greater detail for use at Stringfellow.

And if it was found to be effective, this kind of technology would probably cost in the $100 to $200 per cubic yard range. Which again puts it into that target that I have talked about, of one-hundred to $200,000,000 for total cleanup.

The third category is a new form of thermal destruction, if you will, and it really is not incineration. And one example is a vitrification furnace. It is an unusual kind of furnace, essentially there is a pool of molten glass, very hot molten glass, and into that pool of glass you put the contaminated material.

What is interesting about this technology is what comes out of the furnace is in fact a form of glassy material so that you do not have to do stabilization after this. What comes out is resistant to leaching; that is the metals would be imbedded in the glass and this technology also seems to have the potential to be a low-cost technology. It has not been used in any substantial way, but the furnaces have been used for years, and again, it could be examined.

The fourth technology is in-situ vitrification. This is a technology in the EPA SITE program, the technology demonstration program. Interestingly enough, this technology has just been chosen for a major Superfund site cleanup in Ohio, the Pristine Site. We felt there were some—we had some major concerns about the use of it there. There are still uncertainties about this technology, but in a sense, Stringfellow, I think is an interesting example of a site that is best suited to the use of this technology. This technology was developed for radioactive kinds of sites, but they are trying to sell the technology for Superfund sites.

So these are the four technologies that we think could be viewed as potential cleanup technologies.

I get to the last part of my statement today, which is where we go from here.

Number one, I conclude that the use of soil gas extraction technology, to remove volatile organics, and those are the chemicals that are moving, that have moved offsite, in the groundwater; those are the major contaminants of concern.

Soil gas extraction technology I can tell you unequivocally, turns out to be one of the most effective and low-cost cleanup technologies that we have ever discovered in ten years of work. There are now about a half a dozen companies using this technology in the marketplace today. It is undergoing very, very rapid use, because there is no more cost-effective way to remove volatile organic chemicals from the ground and even if there is groundwater, because you can dewater a site. So I consider this sort of the first step or the next step for permanent remedy for Stringfellow; using soil gas extraction.

And by the way, if this is used before Alternatives 4B or 5, it simply removes the major risk that people have spoken about in terms of excavation and worker exposures. If you remove the VOCs through this technology, you remove the major short-term risk involved with excavation.

What could be done next? We lay out some simple steps for people to consider. To look at these four additional technologies; get some more data, run some more treatability tests, and possibly only do this on two of the four technologies that we have talked about. Doing treatability tests would take no more than about three to six months. The program of looking at some additional technologies, by the way, should last no longer than a year, and would cost less than $1,000,000, probably more like a half a million, at most. So we have here the potential to get a very cost-effective, more permanent remedy through a relatively small amount of additional expenditure.

But I am not talking about delaying things for a year, and in the last paragraph of the testimony I think we get to the crux of the matter of what might be done right now. And I suggest that it is conceivable that a Record of Decision could be issued in a matter of a month or two and that Record of Decision would be an initial Record of Decision, and this is almost normal practice in Superfund. There are many, many sites where several RODS are issued, that deal with the cleanup in a logical sequence.

This Record of Decision that could be issued within a month, or two, or three, would have three basic components. It would commit to dewatering the site. It would secondly commit to using soil gas extraction and immediately move on getting out the volatile organic chemicals. And the third point of this Record of Decision, would be a commitment by the government—federal government—and the state, to seek a permanent source control remedy by committing to a one-year program of expanding the alternatives, the technologies that we have been talking about, and then making a second Record of Decision that would deal with that final source control step and as I say, I am not talking about delaying things for a year, because this initial Record of Decision would actually represent the commitment of the government to move forward immediately on taking some very critical steps at the site.

Thank you.

[The prepared statement of Dr. Hirschhorn follows:]

STATEMENT OF DR. JOEL S. HIRSCHHORN
SENIOR ASSOCIATE, OFFICE OF TECHNOLOGY ASSESSMENT
BEFORE THE
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL RESEARCH,
AND ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
AND THE CALIFORNIA STATE SENATE COMMITTEE ON APPROPRIATIONS

September 10, 1988

OTA appreciates the opportunity to assist the committees in their examination of alternative plans and their costs for cleaning up the Stringfellow Acid Pits hazardous waste site. We have been studying toxic waste site cleanup since 1980, when the Superfund program began. Because of the work done for Technologies and Management Strategies for Hazardous Waste Control published in 1983, Superfund Strategy published in 1985, numerous site case studies, including several on the Stringfellow site, and our recent report Are We Cleaning Up? - 10 Superfund Case Studies, released last June, we are able to comment on the recently released Feasibility Study for Stringfellow.

First, I will comment on the problems we have seen in the selection of cleanup remedies at Superfund sites. Second, I will review the cleanup options presented in the Stringfellow Feasibility Study. Third, I will briefly discuss some other cleanup options that may be able to permanently destroy the site's contamination at an acceptable cost; however, examining any of these additional options in detail would mean further delay and cost until a complete cleanup is reached.

Superfund Lessons

Several important lessons about cleanup technology selection have been learned from the first eight years of implementing Superfund; briefly they are:

o From the beginning of the national cleanup effort, and even today still, there has been widespread use of impermanent cleanup technologies that rely on leaving hazardous waste in the ground, covering it up, buring it onsite, or transporting it to a commercial landfill. These types of cleanups are likely to lead to repeat cleanups in the future. Indeed, the previous actions at Stringfellow are often cited as a classic example of the failure of containment techniques for hazardous waste sites. The American public has overwhelmingly opposed cleanups based on land disposal, increasingly to the extent of not wanting to send their own waste to a landfill in another community.

o Although Congress attempted to send a clear message to the Environmental Protection Agency in the 1986 reauthorization of Superfund that permanently effective cleanup technologies should be preferred, there continues to be an underuse of commercially available and proven advanced cleanup technologies that permanently destroy or detoxify hazardous waste.

o Several types of cost considerations explain the selection of cleanup remedies that do not seem environmentally sound. Responsible parties often are effective in reaching an agreement with the EPA that reduces cleanup cost at the expense of cleanup effectiveness, because impermanent technologies or poor cleanup goals are used, or both. But sometimes responsible parties spend a lot of their own money on testing newer cleanup technologies that offer good remedies at lower cost. States sometimes put pressure on EPA to select a lower cost remedy in order to reduce the amount of money they must match. Communities seem far less effective than responsible parties and States in getting EPA to select cleanups that they prefer, probably because communities often want a more expensive remedy. EPA itself often tries to reduce spending of government money for individual cleanups in order to take actions at more sites.

o The use of the cost-effectiveness concept has been muddled by analyses that evaluate cleanup alternatives based on fundamentally different technologies as if they offer the same type of environmental protection when in fact they do not, and then choose the lowest cost remedy. For example, incineration of toxic waste, which offers a permanent remedy, is often rejected in favor of land disposal, which is impermanent. The distinction between permanent treatment technologies that destroy hazardous waste (e.g., incineration, biological treatment, and dechlorination) versus land disposal, separation technologies (e.g., air stripping and carbon adsorption), and chemical stabilization technologies has not been made consistently and explicitly enough by EPA. The history of Stringfellow tells us that containment actions which seemed (to some) cost-effective at the time they were proposed and implemented can result in speading contamination and enormously high costs to permanently clean the site.

o The analysis of cleanup alternatives in Feasibility Studies often results in a poor decision because some cleanup technologies have not been examined at all or have not been tested on actual site materials to assess their feasibility. The postponement of treatability tests until after the Record of Decision has been issued by the EPA means that some viable alternatives will not get tested at all and will be rejected prematurely. There may also be a bias to affirm the technology already selected later on. Another problem is that FSs often use inaccurate cost data for some cleanup alternatives which results in the rejection of permanent treatment technologies.

The Stringfellow Feasibility Study

This study is one of the most extensive we have seen in the Superfund program. The study is commendable in several respects. There seems to have been a dyanmic process of modifying the cleanup options being examined to allow the use of new information. Moreover, there was a substantial number of treatability tests performed on some cleanup options. The view that some technologies were so new that pilot-scale testing would be necessary prior to use is also commendable. The range of options examined included a good range of treatment technologies, ranging from true waste destruction (incineration) to chemical stabilization. Estimated costs seem accurate. However, we have some reservations about delaying a choice for how to implement dewatering (either by extraction wells or subsurface drainage gallery tunnel) until after the ROD is issued. Extraction wells at hazardous waste sites is considered proven technology, while the gallery approach is not.

We offer the following brief comments on the five major cleanup alternatives evaluated in the FS, with particular reference to the issues discussed above in a more general Superfund context.

o Alternative 2 based on natural flushing and plume management is close to the traditional containment/land disposal option. This alternative does not offer certainty with regard to a permanent remedy. Major uncertainty exists regarding what contaminants will be removed from the site and when. Not only must the community wait for uncertain cleanup, but the transport and fate of the hazardous materials removed is uncertain. The estimated cost of $121 million can be weighed against uncertain future cleanup costs should the alternative prove inadequate in the longterm.

o Alternative 3 based on onsite dewatering, leachate extraction and treatment, and plume management is pretty much a clasic containment approach. The chief uncertainty is whether contaminated soil and hazardous waste can be isolated completely from ground and surface water in perpetuity. Because untreated waste remains onsite, various longterm institutional issues which surround future environmental protection exist, such as future land use. The estimated cost of $147 million could prove to be low if containment fails and future cleanup actions are necessary.

o Alternative 4A based on onsite dewatering, soil gas extraction of volatile organics, in situ flushing of remaining water soluble organics, leachate extraction and treatment, and plume management uses some separation technology (soil gas extraction and flushing) which could be followed by waste destruction. However, major uncertainty remains about the extent of hazardous substances remaining onsite after the cleanup, because metal contaminants and some organics are not likely to be completely removed. In situ flushing is not proven technology for complex sites and has the same kind of uncertainty as natural flushing. A counter argument, of course, is that if such contaminants could not be removed by the soil gas extraction and in situ flushing, then they are likely to remain immobilized at the site. For the most part, this is probably correct; however, we can speculate about changing site conditions--even if only in the long term--that might lead to contaminants being released through water transport, or posing problems through direct contact because of the way the land is used. Changing conditions can include acidity changes that affect metal solubility, temperature changes that affect organic vaporization, and natural disasters such as earthquakes that might result in large scale mighration of the waste. Such longterm uncertainties make the estimated cost of $180 million also uncertain relative to a truly permanent cleanup.

o Alternative 4B differs from the 4A because selective excavation and treatment of hazardous material is done between soil gas extraction and in situ soil flushing. Conceptually, the idea of excavating hot spots of contamination at large sites is sound environmentally and economically. However, the effectiveness of implementing this approach depends on the quality of site sampling to determine the location and size of hot spots, and also on the selection of criteria which define such hot spots; that is, what chemicals and concentrations are used to define the materials to be excavated. What is done with the excavated material is critical, but if it is incinerated and the ash is chemically stabilized and then landfilled onsite, as discussed in the FS, then some degree of permanence is achieved for the whole cleanup. By using soil gas extraction before excavation, the chief short-term risk involving release of volatile organics during excavation is virtually eliminated. It seems, however, that significantly greater site sampling might be necessary to achieve the desired public acceptance and cost-effectiveness of excavating hot spots. That is, under-excavation poses an environmental problem and over-excavation poses an economic problem. The estimated figure of 300,000 cubic yards (weighing 510,000 tons) over seven high contamination areas, based on current information from the Remedial Investigation, is a rather large volume of material as Superfund sites go. This amount, however, is, according to the FS, only about one third of the total amount of heavily contaminated material onsite. Implementation problems associated with very large amounts of material, particularly for the stabilization part of the alternative, are significant, as discussed in the FS. Considering the limits of this alternative, it is an expensive option, at $357 million.

o Alternative 5 is similar to 4B except that all the digable soil onsite would be sequentially excavated, incinerated, chemically stabilized, and redisposed onsite. This alternative offers the highest level of assured, permanent evironmental protection through waste treatment consistent with the law's preference. The FS says that there is 1.35 million cubic yards of digable contaminated material of which 920,000 cubic yards are heavily contaminated. We agree with the comment in the FS that excavating such an enormous volume is a major undertaking that poses a serious implementation problem, aside from the alternative's very high cost of $693 million. Moreover, some contamination would remain beneath the digable material.

Additional Options

A key issue in any FS is whether some potentially feasible and cost-effective cleanup technologies have reached the final stages of evaluation. The main issue at Stringfellow for many years has been true source control; that is, the elimination (to the extent feasible) of the source of ground and surface water contamination through permanent destruction of the site's contamination. For Stringfellow, the high cost of any cleanup, but particularly for cleanup using destruction technology (Alternatives 4B and 5), increases the importance of making sure that the latest technology developments have been adequately considered. That is, it would be highly beneficial to find a low cost treatment technology that could replace incineration and chemical stabilization in Alternatives 4B and 5.

There are four generic possibilities that might accomplish this: advanced chemical stabilization technology; advanced separation technology; nontraditional thermal treatment technology that removes the need for chemical stabilization; and in situ vitrification. All but the last option could be applied to the large volume of excavated material in either Alternative 4B or 5. We emphasize that consideration of any of these possibilities would have to involve further laboratory and pilot-scale work, which means further delay in final cleanup of Stringfellow and additional costs. These disadvantages must be weighed against the likelihood that the cleanup would achieve the highest levels of environmental protection--equal to or better than Alternative 5--at a lower cost, preferably in the $100 million to $200 million range. That is, from a cost-effectiveness perspective, the goal should be to obtain a truly permanent remedy at a lower cost, rather than to compromise the environmental quality of the cleanup by selecting lower cost options such as Alternatives 2, 3, or 4A. The additional cleanup technologies that might accomplish these difficult objectives are:

(1) An advanced form of chemical stabilization that would be effective both on the organic and metal contaminants could be used to treat the excavated material without the use of incineration. Indeed, such technology does appear possible and already has been used successfully at a completed

Superfund cleanup (the Pepper Steel and Alloys site in Florida) where both organic and metal contamination was the problem, although the organic contamination was less complex than at Stringfellow. This stabilization technology is very different than the silicate technology tested for the Stringfellow FS. What is intriguing about the new technology is that its cost could be below $100 per cubic yard. However, use of the technology to date is quite limited, laboratory testing is necessary to find out whether it would be effective for the whole range of Stringfellow contaminants, and it is not clear whether Stringfellow site conditions would allow the creation of the onsite monolith similar to that at the Florida site. Handling very large amounts of stablilization materials is hard and poses problems for the community. Moreover, although very sophisticated data and analysis were used to predict longterm environmental effectiveness in the Florida application, there may still be nagging doubts about it. Still, of the four possibilities not considered in the FS, this one may offer the greatest potential cost-effectiveness.

(2) Since the actual amount of hazardous material onsite is really only a very small fraction of the total excavated material, it would be advantageous to use technology that could separate out the hazardous material from the larger volume to facilite the use of destruction technology on the concentrated, hazardous material. Some form of soil washing that could remove both the organic and inorganic contaminants from the excavated material might be ideal. However, there is now no proven, off-the-shelf soil washing technology for the whole range of contaminants at the site, or those that would probably remain after soil gas extraction prior to excavation. Two solvent extraction technologies in EPA's technology demonstration program are

designed for removing organic contaminants. Using several extraction media in sequential reactors to deal with all the contaminants would increase the cost. A major issue with soil washing is the difficulty in achieving low enough residual levels of contamination consistently on all excavated materials to avoid a secondary, polishing soil treatment that adds to the cost. Theoretically at least, the cost of an effective soil washing technique might be in the $100 to $200 per cubic yard range.

(3) There are some forms of thermal destruction which produce a product that possesses sufficient resistance to leaching that additional chemical stabilization for metals would not be necessary. One case is a vitrification furnace that has been used to convert contaminated soil into glassy, stable material from which metals do not leach. The cost for this approach might be in the $100 to $200 per cubic yard range for the amount of material considered in Alternative 5, although this is only a rough estimate as the technique has not been used commercially in transportable units. If correct, however, it would be cost substantially less than the conventional rotary kiln and infrared incineration considered in the FS. The technique would require extensive testing to demonstrate the absence of air pollution problems.

(4) In situ vitrification might be used to convert the entire contaminated onsite area into a glassy monolith from which metals would not leach. During the heating of the soil, organic contaminants would be either destroyed or collected in an off-gas collection system and then destroyed. Several technical and safety issues remain to be fully resolved and the technology has not yet been tested and evaluated in EPA's technology demonstration program, but Stringfellow seems to be the kind of large site for

which this technology may offer benefits, including the avoidance of excavation. However, the cost would probably be high, but possibly lower than that estimated for Alternative 5.

We also note that the problem of residual organic contamination in undigable soil and bedrock after excavation might be attacked through the use of in situ biogradation. Injection of water enriched with acclimated indigenous biological organisms, oxygen, and nutrients is being used extensively, and it might be used to degrade the deep organic contamination at Stringfellow. As an adjunct to cleanup involving some other primary approach, this might be quite cost-effective.

In offering these possibilities we recognize that it would probably be fruitful to also consider using soil gas extraction technology in the immediate future regardless of what else might be done at the site. Removing volatile organics this way would facilitate nearly any cleanup alternative. Moreover, all the data available suggests that this technique is well proven and very cost-effective. It has recently been selected for cleaning up a major Superfund site in Pennsylvania and is being used extensively in private cleanups.

Considering the unusual nature and history of the Stringfellow cleanup, we offer the following suggestion on how to procede expeditiously, if there is some general agreement that additional cleanup alternatives merit attention:

(1) Additional gathering of information on additional source control options, with special attention given to obtaining data from potential vendors, over a three month period. We emphasize that contractors doing Feasibility Studies have a difficult time keeping up with newer cleanup technologies and that technology developers have the most detailed data on their technologies, which of course requires careful scrutiny.

(2) Selection of two new technical options on the basis of technical feasibility and cost, after community involvement, within three months of completing phase one.

(3) Treatability testing of Stringfellow materials for the two options over a six month period.

(4) Selection of final remedy according to established Superfund guidance.

To sum up, it is possible that a Record of Decision could be issued relatively soon; it might have three basic components. The site could be dewatered. Then soil gas extraction could remove the volatile organics. And the government could commit to expanding the range of source control options, which would lead to a final Record of Decision about a year later. This approach would satisfy current desire to get on with the permanent cleanup of Stringfellow without compromising environmental goals.

Mr. **Brown**. Thank you very much, Dr. Hirschhorn.

Mr. Scheuer.

Mr. **Scheuer**. Dr. Hirschhorn, we found your testimony very interesting.

Although our effort to introduce innovative technologies, like new technology in bioengineering, has not been spectacularly successful.

We consulted you and you were very helpful when we passed this amendment through this subcommittee, George Brown and I, in which we allocated $25,000,000 for research into innovative technologies in the 1986 Bill.

We have the feeling there is a bit of a Catch 22 developing here. We laid out the plan, we allocated monies to investigate innovative technologies, but yet, it is the contractors seemingly who make most of the decisions on technologies. I do not know if EPA knows enough about it to bust some chops and knock some heads together and tell the contractors to lean more in the direction of experimenting with innovative technologies, but the contractors seem to be going the usual way, which is doing what has already been done and tested by time, mostly tested to have been comparatively ineffective and very cost-ineffective. So they are doing what comes naturally, and piling failure on to failure. But the system does not seem to be evocative of real experimentation, which is what the amendment is all about.

You counseled us very helpfully two years ago. So this is the Catch 22. We allocated the money, but in the system that prevails, the contractors make the decision and they tend to do what businessmen have always done, do what they have found profitable in the past, whether it works or not, and not try and do too much experimenting with techniques that may hit them on the bottom line, the cost of these experiments.

How do we get out of this Catch 22, if it is a Catch 22? How do you evaluate what has happened under this amendment and what would your recommendations be to me and George as to how we clear the air and perhaps clarify the legislation so that there really is a system that will produce real scientific experimentation in innovative technologies?

Mr. **Hirschhorn**. Well, I agree with your observation. I deal with this literally every day and it is very clear now that with all the good intent and provisions in the current Superfund statute, nevertheless, we have not made significant progress in the use of better technologies. There are a lot of reasons for this; let me tick off a few.

Number one we still have in EPA, and in state agencies, and certainly in the industrial community, the responsible parties who have to pay for cleanups, enormous interest in minimizing their immediate cost, in spreading the money out. And I think this is a false economic kind of analysis. Because what we still see going on is exactly what happened in Stringfellow.

I remember when I studied the original Stringfellow studies, an actual fact, one of the original studies on Stringfellow, the top recommendation was in fact, a more permanent remedy, and they said, that costs too much money. Well, actually the cost of that—I forget the exact numbers, but it was a pittance—compared to what we are going to spend on Stringfellow. What we have is a shortsighted view on economics. And what we still see in EPA particularly, is an attitude of minimizing that immediate cost on cleanup, and I see this all the time. Whether in fact there are permanent remedies available, newer technologies to use and instead of picking the technology that is good and might cost twenty or $30,000,000 at a site, a typical site, they would tend to pick a remedy that costs one or $2,000,000 and basically use capping for example, that did not work at Stringfellow, and did not work at a lot of other sites; they are still choosing that routinely around the country. So economics and the use of economic analysis and the idea of minimizing costs and to forgetting about the long-term costs, because one of my points is, they are going to pick those low-cost remedies, land disposal, and they are going to create more Stringfellows.

Mr. SCHEUER. Excuse me, Dr. Hirschhorn. A really professional economic analysis would factor in the question of long-term costs and how that adds to the cost effectiveness of what you are doing, if it really works.

We have the concept of life cycle costing.

Mr. HIRSCHHORN. Uh-huh.

Mr. SCHEUER. How much is it going to cost to fix up the remainder of this problem over the life of the problem? And if you just diddle around, doing comparatively inexpensive things that really do not work, and you pile failure on to failure, each year spending money, and you achieve nothing in the end, that is a very cost-ineffective approach, which we really cannot afford.

Now, I would then ask you; you have analyzed the history of the project over the last two years and realize that they are a quite ineffective effort to stimulate the application of innovative technologies. What do we do from here? What advice do you have for me and George about massaging this legislation so that it really produces change and produces application of innovative technologies? How do we make it either mandatory or attractive for the contractors to do something differently, and not just pile failure on failure?

Mr. HIRSCHHORN. Well, one thing to do, I will give you two possibilities:

Number one would be for the statute to more explicitly state the nature and structure of the economic analysis that should be done in any of these kinds of Feasibility Studies and in the Records of Decision.

Essentially, what we have is simply people using the flexibility of the system to conduct intellectually defective economic analyses.

The second thing that we have found, and I have not said this yet today, is that most of the contractors simply do not have current information. In other words, what is missing in the national system, is what we would call information transfer. Superfund is—

Mr. SCHEUER. Is that transfer from where to where? We do not have the feeling that EPA has that information.

Mr. HIRSCHHORN. They do not. So what—

Mr. SCHEUER. So what are we going to transfer from whom to whom?

Mr. HIRSCHHORN. Well, the first step in creating that new system, would be to create an information data base at a central nationwide data base, presumably the EPA should be doing this. I have a feeling if you gave them the money to do this, we all know that what they would do, they would hire a contractor and so it gets kind of vicious. But the first step is to create the information.

The second step is to disseminate and transfer that information out. The point is, Superfund is highly decentralized. Ten regions, EPA regions, and fifty states, and 100 or 200 contractors, are running Superfund. That is a very decentralized system, very inconsistent work going on. Most of the people do not have good information. They do not have the latest information on technology.

Mr. SCHEUER. Where is the latest information?

Mr. HIRSCHHORN. Well, first off, it is hard to get. People are calling us literally every day. There are 100 or so new technologies out there in the last year or two.

Mr. SCHEUER. Look. George Brown already has his pen in his hand. He is writing a piece of legislation about disseminating this information. You see him, he is already at work.

Where is the fund, the fountain, the source of the information? Do we involve industry, do we try and get industry to put together some kind of a collective source of technology at the cutting edge?

Mr. HIRSCHHORN. Absolutely.

This has to be a cooperative effort with American industry.

I often tell people the best source of information about a new technology is from the inventor and the entrepreneur of the company that has developed that technology. You cannot go through third parties.

On the other hand, somebody objective has to be very careful in evaluating that technology, because we all know that the people who want to sell you something are going to tell you a lot of things that are not going to be true. So it takes a very professional, objective analysis of new information. That takes time, it takes effort, and all I can tell you is, there is no organization, there is no entity, and there is no effective program in EPA right now to create that information, to analyze it, to update it and then to transfer it throughout that system that implements Superfund.

Mr. SCHEUER. What should the entity be, and who should we involve in it?

Mr. HIRSCHHORN. I think we have to create—probably what we are thinking of in our work and in our final report, which will come out in mid-1989, I hope, we will be discussing the creation of some sort of new institutional mechanism to deal with the best information on technology and the dissemination of that information.

Mr. SCHEUER. A new cutting edge, innovative technology?

Mr. HIRSCHHORN. Yes.

And some of it, by the way, I hate to use the word innovative, because sometimes what we call innovative, has been around for several years. You know, some people might say this vacuum extraction of volatile organics from soil is innovative. I want to tell you, it has been already used by private industry in their cleanups at probably fifty to 100 sites. That is not innovative anymore, that is proven technology, and it simply is not being adopted fast enough by the government.

Mr. **Scheuer**. Dr. Hirschhorn, let me read to you on the conference report of the Superfund amendment to the Authorization Act of 1986. "Technology transfer: In carrying out the program, the administrator shall conduct a technology transfer program, including the development, collection, evaluation, coordination and dissemination of information relating to the utilization of alternative or innovative treatment technologies for response actions. The administrator shall establish and maintain a central reference library for such information. The information maintained by the administrator shall be made available to the public," and so on and so on and so forth, and this is the legislation that George and I wrote, with your counsel and advice, two years ago. Now, what went wrong?

Was it that the legislation was not sufficiently specific, which to my mind, it does, it lays it right on the EPA to perform this function.

Or is it that EPA just ignored this and just proceeded on their merry way with little or no concern for our legislative instructions.

Tell us which it is and then tell us what we do and where do we go from here to make that a reality.

Mr. **Hirschhorn**. I would say EPA did not take it very seriously. There is in fact, if you had people out of EPA headquarters sitting up here, they would talk for an hour about what they have been doing and implementing that and I would say to you, it is a token, insignificant effort, that has absolutely no real impact on the program.

Mr. **Scheuer**. In the real world, it did not amount to a hill of beans, is what you are saying.

Mr. **Hirschhorn**. Absolutely true.

There is no effective effort going on in this area. And I think Congress has shown enormous leadership, but EPA—

Mr. **Scheuer**. By Congress, you mean George and myself?

Mr. **Hirschhorn**. Yes. I work for all of Congress, but you know, we have had many, many discussions and interactions with EPA people. I know the people running this part of the program and it is just sad that it is considered about the lowest priority one could imagine over there.

And by the way, some of the stuff they have done, it is all contracted out. Again, I just bring that up.

Mr. **Scheuer**. Yeah.

Seems to me it is evident that we have to ask the GAO to investigate what happened to this legislative mandate that is now two years old.

Mr. **Hirschhorn**. I think that would be very appropriate and very useful.

Mr. **Scheuer**. All right, thank you very much, Mr. Chairman. Thank you Dr. Hirschhorn.

[Pause.]

Mr. **Brown**. Senator Presley.

Senator **Presley**. I will just make an observation; I cannot imagine anything like what you have just described here with EPA, a problem with EPA, happening at the California state level. Mr. Cunningham is not here, I said that for his benefit, he is gone—there he is. They do exactly what they are instructed legislatively. I am a little facetious.

You know, one thing I would like to get way back in your testimony, I think you essentially said, maybe we did not get our $10,000,000 worth?

Mr. HIRSCHHORN. Well, I have seen worse Feasibility Studies. I would say this study lacked intensity and drive in seeking a permanent remedy and it could have used more creativity, dug deeper for information, explored more treatability studies in an effort to seek a truly permanent cost effective remedy.

Senator PRESLEY. This study, I cannot recall, took how long?

Mr. HIRSCHHORN. Well, it is hard to say, you know there have been so many different pieces of the RI/FS at Stringfellow; it has been going on for a long period of time. I can tell you it is one of the, if not the most expensive, it is the second or third most expensive RI/FS in the whole country. It is an enormous study effort.

And there is a need for study, but again, you know, one of the points of our work in our June report, is we do see low quality work in these kinds of studies. A lot of mistakes in a lot of these studies. As I say, I have seen a lot worse Feasibility Studies and I really mean that. This, and we have some nice things to say about the study in our formal testimony. It probably ranks as one of the better Feasibility Studies, but I would just give it a lower grade on this aspect of consideration, examination of the best, the newest technology for a permanent remedy.

Senator PRESLEY. Sounds like, and I guess this part of it would be encouraging, it just sounds like the technology is moving almost faster than the studies.

Mr. HIRSCHHORN. That to be fair to contract, is, and why we say we need a more effective information data base. I am talking about using modern computer technology so that people can tap into a computer system and for example, not just learn about the technology, the data from the developer, but interestingly enough, many of these technologies have been and are being used in cleanups around the country. There is no information transfer going on to let these people know that one of those technologies I mentioned was used effectively at a site in Florida. I mean, how are these hundreds of contractors around the country going to know as soon as possible, when newer technologies have been used, and are they getting their hands on that kind of information?

The development of data for that technology at Pepper Steel Site, I have a stack this high of technical data on that technology done for that particular site. That is an enormous wealth of information. I do not think it is getting out very well into the system.

Senator PRESLEY. I think I heard you say also that you feel that with the present technology, if applied, we could do this job reasonably well for the upside of $200,000,000? MR. Hirschhorn. I think that is a very reasonable goal for a permanent remedy, a good remedy, a remedy that the community would find quite acceptable. That environmentally is a good remedy.

I am talking about lowering the cost without sacrificing, without compromising environmental performance; I want to emphasize that. It is not difficult to pick up a $10,000,000 or $100,000,000 remedy; it just does not do the job environmentally.

I guess I would disagree with the statement made by other witnesses, that every one of those alternatives does sort of an equally good job of protecting the environment. I think nothing could be further from the truth, for that range of alternatives. They do not all offer the same environmental protection. So I am talking about that kind of dollar range and I am still talking about a first-rate, environmentally first-rate kind of cleanup.

Senator **Presley**. Thank you, I think you have been encouraging.

Mr. **Brown**. Mr. Clute.

Mr. **Clute**. Thank you, Mr. Chairman, and I appreciate your testimony also, Doctor.

You mentioned in your testimony a fourth alternative technology. What was that and would you describe that?

Mr. **Hirschhorn**. Of the four that I have?

Mr. **Clute**. Yes.

Mr. **Hirschhorn**. The fourth one was in-situ vitrification; it is a technology where you stick basically electrical, electrodes, into the ground, you zap it with an enormous amount of electricity and you turn a volume of soil into glass. You create a monolith, a slab of glass. And it is tough technology. By the way, I listed those four in order of decreasing importance from my perspective, and decreasing possibility of working at Stringfellow. That technology is not cheap. It is complex. There are environmental concerns about heating up an enormous volume of material. I am talking about melting, remember, the site, literally.

I would have some concerns if I lived near a piece of land and somebody came along and said, I am going to melt this piece of land. So it has some technical interest, it has some applicability, it is not low cost, it is very energy intensive; you have to worry about what is happening to the volatile organic chemicals that can be burned off, and they have to be collected very carefully. It has not been used yet on a large scale, it has only been demonstrated on a small scale, really. It is interesting and I think it merits—it should have been looked at closely for Stringfellow, because Stringfellow is exactly the kind of site, theoretically, for which this technology seems to be suited.

Mr. **Clute**. Even with all those problems you just mentioned, you think it might be suited there?

Mr. **Hirschhorn**. In a theoretical sense. I mean, again, I am cautious about it.

Mr. **Clute**. But not practical.

Mr. **Hirschhorn**. I think there are some better possibilities. I think some of the other ones are higher on my list.

I also talked about using some biological technology. You know, I did not have time to mention, but everyone sort of walks away from that deep contamination in the fissures and cracks deep into the site. Actually, that is a very interesting, natural application of in-situ biological degradation, which is again, has advanced light years, literally. I mean, just enormous advances in the last year or so. I can conceive of using some biological treatment to just sort of let the water with enhanced nutrients in it and so on, natural organisms, I am not talking about genetically engineered organisms or anything like that, but we know today how to use some biological technology to seep down into that deep ground and over a period of time eat up at least the organic contamination that is there.

So there are these possibilities.

Mr. **Clute**. I was just curious, do you and your advice and consulting and what have you in your work in Congress, do you work with some of the UCR scientists in regard to Stringfellow or coordinate anything or exchange information? MR. Hirschhorn. No, we have not worked in particular with those people. It is very difficult for us because there are thousands of sites around the country and we do not have the resources to spend a lot of time at all the sites. We get asked to do a lot of work at sites and we turn a lot of it down. We try to do some case studies so that we learn ourselves how the real world is functioning and Stringfellow for us has sort of been an ongoing saga in case study.

We have worked for long years on other sites, too, but we are limited in what we can do.

Mr. **Brown**. Mr. Scheuer.

Mr. **Scheuer**. One last question, Dr. Hirschhorn.

You sort of made it clear you were not thinking about genetically engineered products for cleaning up our environmental mess of toxic waste.

On our subcommittee we have done a lot of work on genetic engineering and there are three great potentials for genetic engineering.

First, new food processes and products. New drug processes and products, the field of drugs, health, medicine.

And the third is in genetically engineered systems, products for environmental cleanup.

Now, for the first two areas, for drugs, medicines, food, agriculture, probably market forces and the incentives of enormous payoffs in new products and substances and systems, provide enough of an incentive for R&D expenditures, capital expenditures, in massive amounts for that kind of R&D.

In the field of environmental cleanup, toxic waste cleanup, some of us feel that maybe the incentives are not there to produce the actual work that ought to be done by what seems to be the enormous potential of genetic engineering to produce organisms and systems and products for environmental cleanup and toxic waste cleanup.

Do you have any reservations about genetically engineered approaches to toxic waste, do you feel there is a potential there? I notice you sort of brushed it aside and said you are only talking about natural biological systems and products.

Mr. **Hirschhorn**. My observation is, first off, the market does seem to be working fairly well. We have about at least fifty companies right now, fifty companies, that are not only researching biological cleanup, but are offering it in the marketplace with natural occurring organisms and I am very impressed by the data on how effective it is to use natural organisms.

Mr. **Scheuer**. Now, you are talking about natural organisms, you are quite right. I am talking about genetically engineered organisms.

Mr. **Hirschhorn**. Well, that is my point, is right now we are doing so well with using naturally occurring organisms, that I would view the genetic aspect as a longer term experiment. I mean, I do not want to dismiss it as a longer term opportunity. And there is in fact a significant research going on in developing genetically-engineered organisms for environmental cleanup. EPA has a major initiative on it.

There is an enormous amount of academic research going on in that area. And I think ultimately it offers a lot of promise, but I think before we go super high tech in this sense, we ought to recognize that the lower tech side of the spectrum is in fact working and working very well. I would not have said that two years ago, by the way, but the data obtained by so many companies, biological cleanup by the way, is in fact being used right now in America for cleanup, mostly in the private sector.

Mr. **Scheuer**. Now, are these hundred or so contractors involved in this field, is the typical garden variety contractor using the state of the art in natural, biological, in the application of natural, biological phenomenon?

Mr. **Hirschhorn**. No. And let me be clear on this.

The use of that biological technology is being driven by the technology developer kind of companies, many of whom do field work. They actually go into the field and clean up sites. That technology is going nowhere in terms of the contractors who are doing RI/FS studies for Superfund.

Mr. **Scheuer**. Now, of course this is the problem that you and I talked about ten minutes ago.

Mr. **Hirschhorn**. Yes, but—

Mr. **Scheuer**. Of getting the knowledge out.

Mr. **Hirschhorn**. Getting the knowledge out. And again, I say to you, the engineering firms who are doing Feasibility Studies are staffed primarily by civil engineers and environmental engineers, people who really do not have the current expertise for example, to deal with leading edge biological technology. That is not what they have right now.

Mr. **Scheuer**. Much less a new genetically engineered product.

Mr. **Hirschhorn**. Oh, absolutely ill-equipped for that.

Mr. **Scheuer**. All right. Herein lies the problem.

Mr. **Hirschhorn**. Yes.

Mr. **Scheuer**. Thank you very much, Dr. Hirschhorn.

Mr. **Brown**. Thank you Dr. Hirschhorn.

Mr. **Hirschhorn**. Thank you.

Mr. **Brown**. I have some more questions, but I will ask them back in Washington.

Our next witness is Penny Newman, Executive Director Concerned Neighbors in Action. We invite you to come up and while you are coming up I will say goodbye to Mr. Scheuer who has to catch his plane back to New York, and has to leave at this point.

Thank you very much, Jim, for being here.

Mr. **Scheuer**. My pleasure.

Mr. **Brown**. No hearing in Glen Avon would be complete without Penny Newman.

STATEMENT BY PENNY J. NEWMAN, DIRECTOR, CONCERNED NEIGHBORS IN ACTION

Ms. **Newman**. I hope I hang on as long as it takes to get Stringfellow cleaned up.

Congressman Brown, Senator Presley and Assemblyman Clute, I thank you very much for having this hearing and offering me the opportunity to provide testimony as we examine treatment options for the Stringfellow site.

This process seems to us, as it must to all of you, to be an experience in deja vu. It seems like we go through the same process over and over and over again. Usually with new faces from the agencies, but the rest of us having to kind of live through it once again.

My testimony is going to be focused on three areas: One is the history of the Stringfellow site as seen from those of us who have lived with it, not simply reviewing reports which depict what has happened, focusing on how we have gotten to this point. I think the history is very important to the decisions that we are going to be making.

I would like to outline the community's goals for a controlled, conservative approach toward a permanent solution and present a proposed plan by which we can proceed with the cleanup of Stringfellow site.

With the history of Stringfellow you take a little bit different perspective when you live with it day after day. Although the Stringfellow site opened in 1956 and operated for sixteen years until 1972, when the Stringfellow Quarry Company closed it down, its presence in the community has been highlighted on those occasions when its contents, the deadly chemicals, have left the legal boundaries of the site and invaded our community. Those occasions in 1969, 1978, 1979, 1980, where verified releases took place, they resulted in the polluting of our water, our soil, and our air.

On July 2nd of 1980, the Santa Ana Regional Water Quality Control Board, the Board that had control of the site, adopted Resolution 80-142, calling for the total removal of all contaminated liquid and solid material from the site and requested funding, all of $11,000,000, from the State Water Resources Board. This was prior to Superfund passage. At the end of July $4,000,000 was available to begin some abatement work. By December of 1980, the Regional Board received cost estimates that had increased the estimate for total removal up to twenty-one to $41,000,000 and found no source of additional funding. So the Board adopted Resolution 80-219 to begin an interim abatement program with the promise to the community that this work would only be to stabilize the site until Superfund money was available when total removal would take place.

The interim abatement plan was very much like some of the alternatives we were looking at today. It called for dewatering, removing all the liquids; establishment of leachate control channels, the drain ditches around the site; removal of DDT, neutralization of material with kiln dust, and they claimed seventy-five percent neutralization of the site; grading of the site with a impermeable multi-layer clay cap added in groundwater management.

In August of 1982, the interim abatement program was completed. The executive officer for the Board was quoted as saying that the site is cleaned up in perpetuity, and he authored a resolution to declare the interim abatement program was the most cost effective method and therefore should be the final solution. It was the first example to the community that officials in charge would not keep, and had no intentions of keeping, the commitments that they had made to this community.

The community responded in outrage and appealed to the governor, the Department of Health Services, by now designated as the lead agency, and the State Water Resources Board to stand by the commitment they made to the community.

As a result, the Regional Board modified the resolution and declared the capping method an interim step and reaffirmed its recommendation for total removal of the chemicals.

But efforts by the staff and EPA continued to push for containment as the final solution. EPA concluded and I quote, "the on-site containment is the most cost effective alternative, and therefore the appropriate final solution."

So how did we get from that point to where we are today, with an extremely expensive Remedial Investigation Feasibility Study and a whole new list of alternatives.

You may note that none of the staff that are currently here were there during that time or have had any experience with the heavy rains that we have had in our community that have resulted in the release of chemicals into Glen Avon. They have no perception of what heavy rains mean. So when you have reassurances by them that this site, as it stands now, will withstand any heavy rains, for those of us who have lived through those commitments and those rains, they do not mean much.

In early 1983 heavy rains proved the point that our community had been trying to make, that containment approaches will not work at this site. The so-called impermeable clay cap began to erode and with it the trust of the community in the competency of the agencies involved in protecting us. The heavy rains made huge gullies through the cap, exposing the white, chalky kiln dust layer and the chemicals below. The drainage channels on top of the cap filled with mud causing ponds to form of a water/chemical mixture and to overflow.

When asked why actions had not been taken to cover the barren dirt of the cap so it would not erode, Tom Bailey, then Section Chief, Toxic Substances Division of DHS, said, "We forgot".

At about the same time the scandal at EPA revolving around Ann Gorsuch Burford, and Rita Lavelle erupted. DHS was negotiating with EPA for a Feasibility Study in order to add more monitoring wells only. Because of the deterioration of the site, the preliminary results from monitoring wells and the questions of impropriety by Ann Gorsuch and Rita Lavelle and the EPA staff. EPA expanded the study into a complete Remedial Investigation Feasibility Study. One official later confessed to me, "We had no idea how serious this site really was."

The community goals. The history of the Stringfellow site has great implication for the decisions we make today and it cannot be forgotten. That history has produced the following facts.

After each round of battles, round of studies, the realization eventually arises that the best permanent solution and the only one that will protect this community, is total removal of the chemicals from the canyon.

The community has a longstanding commitment by the agencies for total removal of those chemicals.

The increased volume of materials at the site, which has increased the cost of cleanup, is a direct result of the actions taken by the State of California, approved by EPA and opposed by the community.

So when we start having the cost that is too expensive to do that, they have no one to blame but themselves for that.

The community's understanding of the site has proven to be more accurate than the so-called experts.

The community does not trust government to act in the right—take the right decisions or to do the work properly if they are left to their own devices.

Stringfellow is unforgiving. Small mistakes become amplified, necessitating that only controlled, comprehensive approaches be used.

Over the past years, CNA has kept the community informed on activities surrounding the Stringfellow site through community meetings, newsletters and staffing of the information center. We have conducted surveys to ascertain the direction the community wants to go in the cleanup process. In other words, we have actually asked people what they think.

All of these efforts have underscored a very clear position. The overwhelming goal of the cleanup has not changed from the goal outlined in 1980; the community wants the permanent removal of contaminants from the canyon. They do not want chemicals left on site. There is a strong belief, based on the history of the site, that as long as the chemicals remain on site, they pose a substantial and continuing threat to our community.

It is believed that the only reason we have not experienced a crisis at this site in recent years, is due to the high profile and thus increased staffing for the site, the continuing pump and treat process that has been taking place and probably most importantly, a number of years of very little rainfall that has impacted the site. We have experienced this kind of rainfall in 1969, 1978, 1979, 1980, and if we were to see it again, we are convinced we would have the same type of crisis situation occurring.

Another clear position that has emerged in our discussions with the community, is that people feel there must be an end to the Stringfellow problem, so that our community can rebuild ourself and we can get on with our lives. A solution involving 400 years is no solution.

The most obvious way of achieving our goal of total removal is to dig it up and haul it away. That method ensures that the contaminants are removed permanently and cannot be released into the community once again. It provides a truly permanent solution that guarantees no future harm to our community from the site.

Although removal of contaminants through excavation and hauling away meets our goal, there may be other approaches that meet that same goal in a better environmental approach. Those approaches are methods that involve treatment of the materials to permanently remove contaminants or those that significantly reduce quantity and toxicity of the waste that remain on site.

If a treatment strategy is chosen over digging it up and hauling it away, then it must be done in a controlled manner. It should not release chemicals into the environment with the hope of catching them, as the flushing method does. A more conservative approach must be taken.

Since Dr. Highland will be addressing the alternatives outline in the FS in more detail, I will limit my remarks to specific issues raised in the report.

First I would like to comment that from the community's perspective, what we have seen outlined, there have been some positive recommendations. I hope Alex is listening, I do have some positive things to say about what the state has done. Although not addressed in today's hearing, we want to commend the state and EPA for their community groundwater recommendation. It is a comprehensive plan that utilizes a controlled method of cleanup and while airstripping was not a technology we eagerly embraced, they have added controls and monitoring in such a way that you really could not require anymore. Our only concern is the amount of time, the two years, before it will be implemented. Since no steps have been taken to stop the migration of the plume from the community, to keep expanding into the Chino Basin, we find that a real concern.

The recommendation for dewatering by using extraction wells, rather than the gallery system, we find is a very positive step. Do you remember, the gallery is the fourteen-foot diameter tunnel that would be drilled underneath this site and holes poked in it for the contaminants to drip into the tunnel where it would be collected. We see the recommendation against this idea as a refreshing return to sanity.

Another positive step is the acknowledgement that vacuum gas extraction is a viable technology and its inclusion in most of the alternatives is reassuring. When we first presented the technology it was met with great skepticism by the contractor and the state. But upon closer examination they have come to acknowledge its potential for solving a major constituent at the site, the volatile organics. Chemicals like TCE and PCE migrate most rapidly from the site into the community's groundwater and they volatilize easily into the air. If they can be removed in a controlled manner, through vacuum gas extraction, a substantial improvement can be made at that site, one that significantly reduces the threat to the community.

We thought that at this point in time, the release of the FS, we would have enough information to actually make a decision on how to clean up that site; we do not. The failure of the FS is that it has not given a comprehensive review of the technologies that are available to actually treat materials. The technologies as combined in the six alternatives presented in the study, offer no real choice. Alternative 1, no action and 2 and 3, which are varied containment strategies, offer no more of what we have now. We feel these approaches will fail as they have in the past, leaving us once again with the great expenditure of precious funding and no solution.

Alternatives 4A and 4B, are even more frightening to us in that they rely on flushing water through the site, releasing chemicals into the environment and hopefully catching them to be treated. The Stringfellow site has a long documented history of failed attempts at controlling the water coming from the site. To now suggest that we can control and catch all of the naturally released contaminants or worse, to force additional water into the site, is the ultimate nightmare to those of us downstream.

Alternative 5, excavation and treatment offers the most acceptable approach, the one coming closest to the community's goal of removal. Except that it limits the treatment to incineration in all practical purposes. It also does not include soil gas extraction, which we would recommend happen.

Many technologies have been eliminated for unclear reasons as in the case of soil washing, wherein I quote the FS, "time constraints preclude a thorough evaluation." We wonder how many potential technologies have not even been examined.

I was pleased to hear Dr. Hirschhorn's testimony, who seems to share our concerns and our feelings, and I am also pleased to hear that Mr. Cunningham said he would be willing to re-evaluate some technologies if the community were willing to go through that delay.

We would like to offer a proposal for consideration by EPA and the state, that does not call for a delay. We feel the Feasibility Study gives us a good beginning, a draft blueprint upon which to begin the final cleanup of Stringfellow. It provides some necessary first steps, but too many questions still remain to really commit to a full program.

We would therefore feel that it would be worthwhile to begin with dewatering of the site through a separate operable unit, begin dewatering it; then use the soil gas extraction to relieve the volatile organics as a separate program, as Dr. Hirschhorn has described.

In our monthly meetings with the Stringfellow Advisory Committee, the state has suggested that these two processes could take about two to three years. While this is being conducted, we propose that a second track take place, in which treatability tests are performed on selected technologies, such as soil washing.

When we first proposed soil gas extraction as a technology that needed closer examination, the state and contractor seemed skeptical. However, both have given it appropriate consideration and it has now been included in the FS. We trust that the state and EPA will come to see the merits of this plan and will join us in its recommendation.

As with the community groundwater cleanup plan, a separate operable unit can be utilized for this specific phase of the cleanup. This will not require any delay since more studies have to be done in order to develop a specific technology anyway. This proposal appropriately places the decision of which treatment is adopted at a time when we have better answers. It is the best approach from the community's perspective, from the technical perspective and from a fiscal perspective. We are not committing to spending $800,000,000 for a treatment that we do not even know if it will work or not and limiting ourselves to one type of approach.

Hopefully we have learned from the past. Caution certainly must take precedence at this site. A step-by-step approach, as we have outlined, ensures that actions of today will not become the mistakes of tomorrow.

I would like to add that I am very dismayed that we have no one from EPA headquarters here to listen to the testimony and explore the options that are available since everyone has admitted, headquarters is the one who will be making the final decision and have to write-off because of the amount of money. We find it a little discouraging, especially since Mr. Thomas had made a personal commitment to me and this community that he would be monitoring this site very closely.

With that, I thank you again for listening to my testimony.

[The prepared statement of Ms. Newman follows:]

TESTIMONY OF

PENNY J. NEWMAN
EXECUTIVE DIRECTOR
CONCERNED NEIGHBORS IN ACTION

BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL RESEARCH,
AND ENVIRONMENT,
AND
THE CALIFORNIA STATE SENATE COMMITTEE ON APPROPRIATIONS

SEPTEMBER 10, 1988
GLEN AVON, CALIFORNIA

Congressman Brown, Senator Presley and esteemed panel members. I appreciate the opportunity to provide this testimony as you examine the treatment options for waste at the Stringfellow Acid Pits. This process seems to us, as it must to some of you on the panel, to be an experience in deja vu. My testimony will briefly review the history of Stringfellow site focusing on how we got to this point; outline the community's goals for clean up and our desire for controlled, conservative approaches; and present a proposed plan by which we can proceed with the clean up of the Stringfellow Acid Pits.

History of the Stringfellow site

Although the Stringfellow Site opened in 1956 and operated for 16 years until 1972 when the Stringfellow Quarry Company closed it,[1] its presence to the community has been highlighted on those occasions when its contents - the hundreds of deadly chemicals, have left its legal boundaries to invade our community. In 1969, '78, '79, and '80, verified releases took place that resulted in the polluting of our water, soil, and air.[2]

On July 2, 1980, the Santa Ana Regional Water Quality Control Board adopted Resolution 80-142 calling for the total removal of all contaminated liquid and solid material from the site, and requested funding (only $11,288,250) from the State Water Resources Board.[3] (This is prior to the passage of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) more commonly called Superfund). At the end of July, $4,036,000 was made available to begin abatement work. By December of 1980, the Regional Board received cost estimates of between $21 and 41 Million for total removal, but had found no source for additional funding. The Board adopted Resolution 80-219 to begin an "Interim Abatement Program" with the promise to the community that this work would only stabilize the site, until Superfund money was made available, when total removal would take place.[4]

That Interim Abatement plan called for the removal of all liquid (dewatering), establishment of leachate controls (drainage channels around the site), DDT Removal, Neutralization of material with kiln dust (they claimed neutralization of 75% of the site), Grading with an construction of an impermeable multilayer clay cap, and groundwater management.[5]

In August of 1982, The Interim Abatement Program was completed.[6] The Executive Officer for the RWQCB, was quoted as saying that the site was cleaned up in perpetuity, and authored a resolution to declare the Interim Abatement program the most cost-effective method and, therefore, the final solution. It was one of the first examples to the community that officials in charge would not keep, and had no intentions of keeping, the commitments they made to this community. The community responded in outrage, and appealed to the Governor, the Department of Health Services (the designated lead agency under the State's new Superfund law) and the State Water Resources Board to stand by their commitment to our community. As a result, the Regional Board modified the Resolution and declared the capping method an interim step and reaffirmed its recommendation for total removal of waste.

But efforts by the staff and EPA continued to push for containment as the final solution. EPA concluded that the "on-site containment . . . is the most cost-effective alternative and therefore, the appropriate final solution."[7]

So how did we come to the point we are today, with an extremely expensive Remedial Investigation/Feasibility Study and a whole new list of alternatives?

In early 1983, heavy rains proved the point our community had been trying to make - that containment approaches won't work at this site. The so-called "impermeable" clay cap began to erode, and with it any trust this community had in the competency of the agencies that were supposed to protect us. The heavy rains made huge gullies through the cap exposing the white chalky kiln dust layer and chemicals below. The drainage channels on the cap filled with mud causing ponds to form and a water/chemical mixture to overflow.[8] When asked why actions had not been taken to cover the barren dirt of the cap so it would not erode, Tom Bailey, Section Chief, Toxic Substances Division, for DHS said, "We forgot."[9]

At about this time the scandal at EPA revolving around Ann Gorsuch Burford and Rita Lavelle erupted. DHS was negotiating with EPA for a feasibility study in order to add more monitoring wells. Because of the deterioration of the site; the preliminary results from monitoring wells; and the questions of impropriety by Ann Gorsuch and Rita Lavelle, EPA expanded the study into a complete Remedial Investigation/ Feasibility Study. One official later confessed to me, "We had no idea how bad this site really was."[10]

Community Goals

This history of Stringfellow has great implication for the decisions we make today and it cannot be forgotten. That history has produced the following facts:

- After each round of battles, the realization arises that the best permanent solution and the only one that will protect this community, is total removal of the chemicals from the canyon.
- The community has a long-standing commitment by the agencies for total removal of the chemicals from the canyon.
- The increased volume of materials at the site (increasing the cost of cleanup) is due to actions taken by the State of California, approved by EPA, and opposed by the community.
- The community's understanding of the site has been more accurate than the "experts".
- The community does not trust the government to make the right decisions or to do the work properly, if left to their own devices.
- Stringfellow is unforgiving. Small mistakes become amplified, necessitating that only controlled, conservative approaches be used.

Over the past years, Concerned Neighbors in Action has kept the community informed on activities surrounding the Stringfellow site through community meetings, newsletters and staffing the Information Center. We have conducted surveys to ascertain the direction the community wants in the cleanup process. In other words, we've asked people what they think.

All of these efforts have underscored one clear position- the overwhelming goal of the clean up has not changed from the goal outlined in 1980 - the community wants the permanent removal of contaminants from the canyon - they don't want chemicals left on-site. There is a strong belief (based on the past history of the site) that as long as the chemicals remain on-site they pose a substantial and continuing threat to our community.

It is believed that the only reason we have not experienced a crisis at the site is due to the high profile and thus increased staffing, the continuing "pump and treat" process to control water, and probably most importantly, a number of years with very little rainfall. If we experience the same rainfall as 1969, '78, '79 and '80 we very well may be in the same crisis situation that occurred in those years.

Another clear position has also emerged in our discussion with the community. People feel that there must to be an end to the "Stringfellow Problem" so that the community can rebuild itself and we can get on with our lives. A solution involving 400 years is no solution!

The most obvious way of achieving our goal of total removal is to "dig the site up and haul it away". That method ensures that the contaminants are removed permanently and cannot be released into the community once again. It provides for a truly permanent solution that guarantees no future harm to our community from the site.

Although removal of contaminants through excavation and hauling away meets our goal, there may be other approaches that meet that same goal. Those approaches are methods that involve treatment of the materials to permanently remove contaminants or those that significantly reduce the quantity and toxicity of wastes that remain on site.

If a treatment strategy is chosen over "digging up and hauling away", then it must be done is a controlled manner. It should not release chemicals into the environment with the hope of catching them, as the flushing method proposes. A more conservative approach must be taken.

Comments on the Feasibility Study

Since Dr. Highland will be addressing the alternatives outlined in the FS, I will limit my remarks to specific issues raised in the report.

First, I would like to comment on what, from the community's perspective, are seen as positive recommendations made in the report.

Although not being addressed in today's hearing, we want to commend the State and EPA for their community groundwater recommendation. It is a comprehensive approach that utilizes a controlled method of cleanup, and while airstripping was not a technology we eagerly embraced, the added controls and monitoring are as protective as one could require. Our only concern is the amount of time, two years, before it is implemented. Since no steps have been taken to stop the migration of the plume in the community, waiting two more years only expands the area of the Chino Basin to become contaminated.

The recommendation for dewatering by using extraction wells rather than the gallery, or adit system, is a great relief. This was the 14′ diameter tunnel to be drilled under the site with holes drilled into the contamination allowing it to "drip" into the tunnel where it would be collected and treated. We see the recommendation against this idea as a refreshing return to sanity.

Another positive step is the acknowledgement that vacuum gas extraction is a viable technology and its inclusion in most of the alternatives is reassuring. When we first presented the technology it was met with great skepticism by the contractor and the State. But upon closer examination they have come to acknowledge its potential for solving a major constituent at the site, the volatile organics. Chemicals like TCE and PCE, migrate most rapidly from the site into the community's groundwater and they volatilize easily into the air. If they can be removed in a controlled manner through vacuum gas extraction, a substantial improvement to the site will have been made - one that significantly reduces the threat to the community.

But there are disturbing aspects of the FS as seen by the community. The technologies, as combined in the six alternatives that it be selected utilizing extraction wells. This process should then be followed with soil gas extraction to remove volatile organics. These two steps combined would help curtail a major route of exposure (subsurface water) and remove a significant amount of those contaminants that pose the greatest risk to the community - those that migrate easily in water and readily volatilize into air.

In our monthly Stringfellow Advisory Meetings it has been suggested that these two processes may take 2-3 years. While this is being conducted, we propose a second track take place in which treatability studies are performed on selected technologies, such as soil washing.

When we first proposed soil gas extraction as a technology that needed closer examination, the State and contractor seemed skeptical. However, both have given it appropriate consideration and it has been included in the FS. We trust that the State and EPA will come to see the merits of this plan and will join us in its recommendation.

As with the community groundwater cleanup plan, a separate "operable unit" can be utilized for this specific phase of the cleanup. This will not require any delay in the process, since more studies are needed to progress in the development of a specific treatment plan anyway. This proposal appropriately places the decision of which treatment we adopt at a time when we have better answers.

Hopefully we have learned from the past. Caution certainly must take precedence at this site. A step by step approach, as we have outlined, ensures that the actions of today won't become the mistakes of tomorrow.

ENDNOTES

[1] State Water Resources Control Board, Interagency Status Report, "Stringfellow Hazardous Waste Disposal Site". October, 1980. p.7.

[2] Ibid.

[3] Santa Ana Regional Water Quality Control Board, "Stringfellow Class I Disposal Site", Interim Abatement Report (Phase 3), Report No. 15, April, 1982. p 1.

[4] Trezek, G.J. "Engineering Case Study of the Stringfellow Superfund Site", a report for the Office of Technology Assessment, Congress of the United States. August 1984. p. 37.

[5] Santa Ana Regional Water Quality Control Board, pp. 3-8.

[6] Trezek, p.39.

[7] Santa Ana Regional Water Quality Control Board, p. unnumbered.

[8] News clippings, 1983.

[9] Bailey, Tom, Meeting in Glen Avon, 1983.

[10] Weiner, Peter, Personal Communication, Fall, 1983.

Mr. **Brown**. Thank you very much. Your testimony is very helpful to us and shows a sophisticated understanding of the site in addition to, of course, a very strong concern, which you have always had and I hope you always will have, for protecting the interests of the community.

Senator Presley.

Senator **Presley**. I agree with what you said.

Mr. **Brown**. Mr. Clute.

Mr. **Clute**. Yeah, I certainly want to thank you Ms. Newman. I know that your leadership in this area has certainly helped me try to stay focused and tuned in.

I wanted to ask you, on your plan for the final cleanup, you mentioned dewatering, soil gas extraction and then concurrently a treatability test. And then what was it after that?

Ms. **Newman**. Once the treatability tests are completed, and we have some information, such as Dr. Hirschhorn has described, and I am glad that he mentioned some specific technologies, then we can re-evaluate issuing another ROD, go through the actual decision-making process on which treatment to use. I think it is premature to pick a treatment right now, because all we are being given is, the only real treatment, is $800,000,000.

And you know, I think it is interesting too, I hope that we do not get caught into putting a cap on the cost of cleanup. Because we would be kind of limiting ourselves if something becomes available that may be over $200,000,000, not nearly $800,000,000, but still do the job appropriately. I think if we look at any other situation in which somebody has damaged your property or your area, we would not apply the same kinds of process that we seem to keep doing here. It is kind of like having somebody run into your car and damage it and then tell you, well, I have $200 here to fix it because of all the other sites that I have already damaged, so therefore, you pick out the dents you want removed and I will pay for that.

Mr. **Clute**. Yeah.

Ms. **Newman**. We would find that outrageous, and I think the community would also take that same approach: We did not create this site, you know, the industries, the responsible parties did, and the State of California and EPA certainly contributed to it. So, let us keep it open and come up with a really, truly permanent solution.

Mr. **Clute**. So you would say that the dewatering and the soil gas extraction could start relatively soon.

Ms. **Newman**. Yes.

Mr. **Clute**. And then while that takes about two to three years, the other testing would provide perhaps some final, feasible alternatives.

Ms. **Newman**. Right.

And the state and the contractor have admitted that they need to do more testing to define and develop the treatment technology anyway.

What I am saying, instead of locking ourselves in to a decision of containment or spending $800,000,000 for incineration, which may not be the most appropriate way, let us leave that final decision on treatment until we have some more information.

Mr. **Clute**. Let us take another point and that is the local drinking water and general use of water as far as in bathing and those types of uses, today in this area. What is the extent of bottled use of water for drinking and what else is being done, as far as the use of water by people in this area?

Ms. **Newman**. Well, luckily, because of efforts by you and Senator Presley in getting an alternative water system for people and private wells in the area, people have reassurance of having a good quality water at this point. I think there is still, because of the past history, where people were told previously that their water was clean, I think there is still a real desire to continue with bottled water or filtered water, in addition to the water system they may have, just as a reassurance. You know, kind of an extra safeguard. It is a little hard for people to trust what they are told after being lied to so many times in the past.

Mr. **Clute**. Is there presently any subsidized financial assistance in bottled water use?

Ms. **Newman**. No, not that I am aware of, unless there are for a few families in which they have not been hooked in to the water system yet.

Mr. **Clute**. Do you think at this point that there should be?

Ms. **Newman**. From the test results I have seen from Jarupa Community Service District, I feel confident in the water quality as far as any contaminants from the Stringfellow site impacting it. I have not seen any of that. And I would not proclaim that there is a problem with that. I would encourage people to keep track of the tests that are done for early indicators, but I have perfect confidence in the water at this point.

Mr. **Clute**. Thank you.

Mr. **Brown**. Ms. Newman, some reference has been made to the fact that we are now in a position to provide community groups with scientific consultants and you have been operating under that.

Ms. **Newman**. Yes.

Mr. **Brown**. Could you give us an evaluation as to the, first the importance of doing this, and secondly, is it working adequately to meet the needs of the community?

Ms. **Newman**. I think it is one of the most important programs that EPA has come up with, actually Congress came up with and made EPA implement it.

The technical advisor that we have, which you are going go hear, and I think you will find for yourself how impressive his presentation is and his understanding of it. His ability to be able to translate the technical information into language that all of us can understand, has been extremely helpful. He has been extremely helpful in directing us and helping us understand where we need to go and taking our concerns and interpreting that into the Superfund process and how it fits in. And that has been most helpful.

I think that the program that has been outlined by EPA for these technical assisted grants, has met with the problem that a lot of programs do when they meet the bureaucracy, in that there are so many restrictions put on it and so many hurdles the community groups have to go through, coming up with thirty-five percent matching funds in order to get a technical advisor, is a huge burden to put on to a community group. Most community groups living near these Superfund sites, may have all of $200 in their bank at any one time, and for them to come up with a huge amount of money is very, very difficult. I have seen the application form for the technical assistance grants, and it is like this, you know, it is like every other bureaucratic program, it is extremely difficult for the layperson to get through.

Although the goal of it is excellent, and I would encourage community groups to go for it, you know, to attempt to get it, it is going to be a real burden on the communities to try and meet all the paper work. I am glad that we do not fall under that at this point. We have not had to do that. We have been lucky in having the first one years ago, when they did not have time to make up rules, so we have kind of made them up as we have gone, and reached agreements on what could happen and what could not happen with the advisor, and I think everybody would agree that it has been a very beneficial program for us.

Mr. Brown. All right. Thank you very much for your testimony. And as you indicated, our last witness will be Dr. Joe Highland of the ENVIRON Corporation, of Princeton, New Jersey.

Now that you have been highly complimented, we look forward to your testimony.

STATEMENT OF JOSEPH N. HIGHLAND, SENIOR VICE PRESIDENT, ENVIRON CORPORATION

Mr. Highland. Thank you, Congressman Brown, Senator Presley, Assemblyman Clute.

I welcome the opportunity to present testimony to you. You have my prepared testimony, my written testimony, so I will avoid reading it. I would like to highlight several points from it, and I would like to add to it, based on a recent experience I had within the last two weeks, following the submission of this written testimony.

As you are aware ENVIRON is the technical consultant that you have been discussing. We have been in that position for the last three years. I and my colleagues have tried to provide assistance at a technical level to the community members and help them understand the alternatives and recommendations that have been made.

Let me focus on the fact that I believe Ms. Newman has stated very clearly today and in the past, what the goals of the community have been and continue to be. Those are the removal of the chemical contaminants from the site in order to preclude short-term or long-term risks from occurring in the future.

I think it is important also to realize that the goals of the Superfund Amendments and Reauthorization Act, SARA, are really consistent in the sense that they strive to have alternatives, which are permanent solutions. Solutions which detoxify contaminants, remove contaminants, decrease their mobility, reduce their volume and I think there is a consistency in terms of goals that are to be met.

I then look at the goal and I think, as Ms. Newman also indicated, there is a sense that if contaminants are to be removed, it should be in a controlled fashion and one that does not endanger the community and the surrounding neighborhood, in the process. If you take the goal to be removal of the contaminants or reduction of mobility or volume, in a controlled fashion, you can then look at the Feasibility Study and the alternatives presented and reach a judgment as to whether they can effectively meet the goal.

Now I think there is a spectrum of alternatives, obviously, and they were discussed in detail during prior testimony, so I will not go through them in that detail. But let me just comment, that if you look at them, and you start down at the number 1. Obviously, as everyone has said, that is a requisite alternative. It is not given serious consideration here, so you can basically eliminate it.

If you look at 2 and 3, they really do not go to dealing with the source of the problem. They go to, at best, treating the groundwater. And Alternative 3, to trying to contain contaminants on site. So in a sense, they cannot really meet a goal of both the community and SARA in the sense that they do not provide a reduction of the source, they do not provide the ability to immobilize or to remove or decontaminate those materials.

You then get to what are called the mixed-treatment actions. And really if you look at what is defined as treatment here, you will see that there are really three treatment technologies offered, and they fall within these various options, 4A, 4B and 5. They are the vacuum gas extraction, which people have spoken to previously as a worthwhile and meritorious approach, because it really does as a technology, address the concern. It takes an important subgroup of chemicals, which are present at the site, those which are most mobile, those which have been found in the groundwater supply down in the community, and it removes them in a controlled fashion, so as not to create a further endangerment and to meet the goal of permanent removal.

The other two technologies however, do not provide the same level of comfort. One is in-situ flushing, where you mobilize, as you have been told, the contaminants from the site and prior testimony suggested that when you mobilize them and recapture them, that was a "closed system". I take issue with that, it is not a closed system. There is no way that anyone, consultant, government agent, industrial representative, can sit before you and testify that when you release the contaminants you will be able to totally recapture them. You would hope engineering-wise to recapture most of them, but at this site, with the fractured rock that exists here, there are severe restraints on the ability to recapture. So it is not a closed system and it is one that could allow contaminants to emanate from the site in an uncontrolled fashion and potentially reach the community.

The other option is incineration. So I am going to include and raise several issues with respect to incineration in this particular air basin of location. We are going to present detailed, technical comments at the public meeting, either on the 20th or later than that, if there is another one, which will address some of the shortcomings we believe in the analysis to date.

But let me also suggest to you, prior testimony which said there will be no emissions, is absolutely incorrect. There will be emissions and that is not a statement against incineration. It is a statement to say that you have to be realistic in understanding the engineering device that you are to use. The best air pollution equipment put on any type of thermal destruction, equipment as has been evaluated or proposed like a rotary kiln, leads to emissions. Now the magnitude of those emissions can be evaluated, but there will be emissions and there are concerns. It is not a zero emission system.

Now, these options that you see before you in the Feasibility Study, are really not new options to us. We have been attending (since the beginning of this year) monthly meetings as were mentioned earlier in testimony, in which these options specifically were discussed. And seeing the shortcomings in terms of these options, we raised to both EPA and the state, the question of whether other alternative technologies could be considered. We sought to find technologies which would meet the goal of both SARA and the community; that is removal of contaminants.

We suggested that the technology needed for consideration was soil washing. We were told initially that soil washing had been considered and that a study in fact had been conducted. On further inquiry we found the study had been set up, but was aborted in the beginnings of that study and never completed. I think there was an honest discussion that the results of that study were inadequate to judge the value, the potential value, of soil flushing as a technique.

It was not three weeks before the issuance of the document that we had serious discussions on soil washing. It was months before the issuance of the June document that we had those discussions. In fact, I think, two, three, or four months before, I remember testifying and presenting evidence to EPA, its contractor and the state, on the issue of soil washing as a remedy to be considered. When we discussed it further we were told it would be considered in the Feasibility Study. But I would suggest to you that the consideration is not an appropriate one at this point. It falls far short of what that technology deserves. And that is not to endorse the technology as one today that could be applied, but to suggest that a lot more could be done with that technology, and perhaps others, as Mr. Hirschhorn has suggested, that would go further toward meeting the goals of SARA and the community, and need to be undertaken.

If you read the Feasibility Study, soil washing is discussed, some of the latest technologies are mentioned, but really two sentiments come out of the Feasibility Study, as well as the meetings I attended.

One, there was not enough time for review of this technology, and that is stated directly in the Feasibility Study.

Second, we were told that the technology which we were suggesting, really was only being supported by the vendor, and that people were skeptical whether the vendor was providing a fair and just understanding of the capabilities of the technology. We asked whether the vendors would be contacted further, whether officials of the German EPA, who we believed had information on the technologies would be contacted further, and to my knowledge, there was no further undertaking and we got the publication and Feasibility Study.

At that point we decided that the best thing to do was to try to inquire about that technology ourselves, and two weeks ago I went to Germany and met with the German EPA to discuss soil washing as a technology. I met with one of the vendors, Harbauer Corporation, that had produced papers on the technology, to find out whether in fact this technology really offered something that might be useful at this site.

The trip was very worthwhile. The people from the Umbelt Bundesampt, German Government, indicated that there were ten companies now actively involved in developing soil washing techniques. That two of those companies, Harbauer and Klockner, were in the lead, and that both were actually involved in soil washing cleanups of sites in Berlin. One at the Pinch Site, which is an old oil reclaiming site. I had the opportunity to go to and see. It is a site where, when they could not reclaim the oil, they dug trenches and dumped the oil and contaminants into the ground. It is a highly contaminated site, both in terms of soil and groundwater. The other industrial site in Berlin is where Klockner has a machine in operation. Both companies now have second machines planned or being built for additional sites outside of Berlin and both, according to the German EPA, have successfully used their techniques to clean up soil and to clean up groundwater, at least in terms of the Pinch Site.

The Umbelt Bundesampt is actually funding further research work and working with these companies in a partnership to try to advance this technology, and it is interesting why the technology appears to have developed, especially in Berlin, because I was told as we walked around and obviously all know, there is a wall around the city and there is simply no place to take contaminated soil and to dump it. And you have to reclaim the soil they said, and that has been one of their motivations to reclaim the soil and reuse it. They viewed our situation as one where in many cases we would take our soil from one place to another and just dump it somewhere else, and that simply was not an avenue of approach they could use.

So I think it is fair to say that it is not only the manufacturers of the technology who support it, say it can work, it is also the officials that I met with at the German EPA. I also, as I said, had a chance to visit one of those companies, Harbauer, which for the last several years has been working at the Pinch Site, as I mentioned. Today it is a firm of about forty people, $10,000,000 of revenue, ten to twenty percent of that generated by soil washing.

It is interesting to note that at the Pinch Site, their costs for their charging for the cleanup, is approximately $100 a ton for the soil. They have specific protocols which they provided to me, that is, if the Stringfellow site were in Germany, what would they do to evaluate their technology. They have laboratory skill, bench-scale-type evaluations they can do. They have smaller versions of their large machine, which they can use. They gave me estimates of time, volume of soil that is needed to evaluate their technology and costs, starting with a cost of approximately $2,500 or $3,000 to do the first analysis, to see if the technology might have application, going on up to $25,000 to $50,000 to get to a point of understanding how best to use the technologies of the soil, and subsequently for full-scale runs in their machine, for a day or two to demonstrate the actual feasibility on a large scale. They were talking about costs on the order of $25,000 to $50,000. Now, those are large sums of money on a personal basis, but obviously with respect to the site, those are trivial amounts of money.

I am not here to support Harbauer, I am not here to say that that technology will work at the Stringfellow site. But I am here to say that I think that that technology, the Klockner technology, the soil washing concept, has just simply not been given fair evaluation to this point. If I can fly to Germany, meet with those people and get hard data information and protocols for evaluation, so can others.

So, I guess the question is, where do we go from here? I think as I said, a goal has been defined. A goal has been defined by SARA, a goal has been defined by the community that has been affected for years by the presence of this site. The goal is a permanent solution, not an interim solution. The goal is, from the community perspective, a controlled removal of contamination, not one which is uncontrolled. And it is one that has to be a cost-effective Approach.

If we look at the FS today, we have choices, but they are not complete and they do not satisfy the needs.

Ms. Newman has proposed that we can move forward with part of our work at the site and certainly that seems technologically feasible and appropriate. And at the same time, we do not need to go back to the drawing boards, we do not need to stop, but we can advance our state of knowledge with soil washing or some of the other technologies, which may be available to us. Certainly technologies which can meet the goals of removal, should be in the first tier of consideration.

Technologies like Mr. Hirschhorn mentioned, which are more containment strategies, might fall into a second tier. They may be the final choice at this site and if one thinks of isolating residual materials on site, having some kind of treatment technology to add some redundancy, to add some backup to the system, is perfectly appropriate. There is time that could be used in the next several years as work advances on groundwater treatment in the community, on dewatering the site, on the vacuum gas extraction work, to effectively evaluate soil washing as a technique, to make the judgments that need to be made.

You can review the ten groups that are working in Germany today, you can select one or two of the best ones, you can provide soil in the amounts of two to ten pounds to start with, to these organizations and have them do the experimental work. You can obtain results from them in six months to a year and you can determine at that point whether the technology really has an application here or not.

Likewise, with the other technologies which may fall to a second tier in terms of treatment and containment, similar work could be undertaken.

So in conclusion, I would say, at this point, we will provide detailed technical comments on the Feasibility Study. But more importantly than that, there is a need for consideration of alternative technologies; I would pose to you soil washing as one that could meet the goals of the community, meet the goals of SARA, advancing in Germany at a rapid pace, as something to be clearly and promptly evaluated, along with other options so that no time will be lost and in the end, a proper determination can be made.

Thank you very much for the opportunity to testify.

[The prepared statement of Dr. Highland follows:]

ENVIRON

September 1, 1988

FEDERAL EXPRESS

NRARE Subcommittee
Room 388, House Annex 2
Washington, DC 20515

Re: Hearing on Cleanup Plans and Costs for Stringfellow Acid Pits Site, September 10, 1988

Dear Sirs:

On behalf of the Stringfellow Advisory Committee I am pleased to provide the following testimony in response to your invitation of August 5, 1988. As you are aware, ENVIRON has served as technical consultant to the Stringfellow Advisory Committee since 1985. In light of this service, my testimony will address the remedial alternatives proposed in the Draft Stringfellow Feasibility Study, particularly with regard to how well the remedial alternatives meet the community's goals for cleanup and the statutory requirements of the Superfund Amendments and Reauthorization Act (SARA) for permanent remedies. More detailed comments on the Feasibility Study as a whole will be provided in additional testimony at the September 22, 1988 public hearing.

The basic contention of my testimony will be that there are shortcomings with some of the existing technologies included in the proposed remedial alternatives, and that one technology in particular, soil washing, has not been evaluated adequately. In the following I propose to: (1) outline the cleanup goals for the community and of SARA; (2) briefly review the remedial alternatives under consideration; (3) point out some of the shortcomings in the technologies incorporated in these alternatives; and (4) present information that suggests soil washing should be given further consideration.

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Cleanup Goals

To date, cleanup actions implemented at the Stringfellow Site have focused primarily on the isolation of on-site sources of contamination. These actions have been ineffective in preventing further release of contaminants into off-site ground water and have only marginally mitigated existing off-site ground water contamination. Understandably, based on the poor performance of past cleanup actions, the local community feel that there remains a substantial and continuing threat to the community as long as the contaminants remain on-site.[1] Ideally, therefore, the community's preferred cleanup solution would be the removal of the contaminated soil and ground water from the site so that there is no longer a threat to the community. In essence, the community wishes to see a permanent solution to the problem, not a continuation of attempts to contain the contaminants on-site. While digging up the entire site and taking all the contaminated material away would obviously meet that goal, the community realizes that its goal can also be met by applying on-site treatment technologies to remove the contaminants from the soil, so that the site no longer acts as a source of contamination.

Similar preferences are expressed in Section 121 of SARA which states that site remedies should provide long-term protection and that preference should be given to permanent remedies which significantly reduce the volume, toxicity, or mobility of a waste or hazardous contaminants. It is my interpretation that this suggests that cleanup alternatives relying on permanent removal or treatment solutions should be favored over containment methods, which may be subject to failure at some point in the future. Thus, the goals of both citizens and the government are consistent in seeking a permanent solution to site cleanup.

Achieving this common goal can perhaps be best met through implementation of controlled on-site treatment technologies designed to significantly reduce the quantity of hazardous contaminants that remain on-site without risking the release of these same contaminants into the environment in the process. From the community's perspective, acceptable technologies are those that not only remove contaminants, but can also be applied in a controlled way so that contaminants are not simply displaced or released from the soil into another component of the local environment, such as the ground water or the air, and so may lead to increased exposure to the community. In constructing a comprehensive cleanup program for the Stringfellow site, preference should be given to technologies that reduce waste quantity and toxicity and pose the least potential for release of chemicals into the environment in the process.

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[1] Newman, P.J. 1988. Letter on behalf of Concerned Neighbors in Action to Ted Rauh of the Department of Health Services. April 12.

Remedial Alternatives

In addition to the requisite no-action alternative (Remedial Alternative No. 1), five remedial alternatives have been evaluated in the Feasibility Study. These remedial alternatives differ in the actions proposed to address on-site soil and ground water contamination - the source of continuing contamination - on which my testimony will focus. Remedial actions for cleaning up off-site ground water are the same for each remedial alternative and will be evaluated in detail as part of our overall review of the Feasibility Study, to be presented at the September 22 public hearing.

Remedial Alternative No. 2 relies on natural flushing of the on-site area. Improved runoff control and a multilayer cap are intended to prevent further ground water contamination by diverting rainwater away from on-site contaminated soil. This alternative does not attempt to control the continuing release of chemicals into on-site ground water and would therefore be relatively ineffective in controlling the release of chemicals from the site in the next several decades. Remedial Alternative No. 3 is basically the same as Alternative No. 2.; however, flushing of on-site ground water contamination is assisted through dewatering the site. This alternative is basically a hydraulic isolation approach with only marginal reduction of on-site waste volume by removal of contaminated ground water. Remedial Alternatives Nos. 2 and 3 both do relatively little to remove on-site contaminants; no treatment technologies are proposed to remove the source of contamination. To differing degrees, these two remedial alternatives offer to isolate the contaminated on-site soil from contact with ground and surface water. Clearly, from the community's view, these two alternatives are unacceptable since they do not offer effective treatment or removal of the contamination source.

Remedial Alternatives Nos. 4A and 4B utilize the surface water controls and dewatering of Remedial Alternative No. 3 and address removal of on-site soil contamination. Two treatment technologies, vacuum gas extraction (VGE) and in situ soil flushing, aimed directly at removing contaminants from the contaminated soil are included. Remedial Alternative No. 4B attempts to shorten the time necessary to complete soil flushing by excavating the most contaminated areas and treating this soil via incineration and chemical stabilization. Finally, Remedial Alternative No. 5, in addition to on-site dewatering as in Remedial Alternatives 3, 4A, and 4B, consists of excavating all "digable" contaminated soil and treating this soil via incineration and chemical stabilization.

Evaluation of Technologies

The remainder of this testimony addresses how well the principal treatment technologies used in Remedial Alternatives 4A, 4B and 5 meet the goals of the community and of SARA. I have focused particular attention on the level of control in contaminant removal afforded by each technology, since multi-media control of potential releases and the incorporation of safety factors or redundancy, in the final remedial alternative will be an important consideration in gaining acceptance by the community.

(1) Vacuum Gas Extraction

Vacuum gas extraction (VGE), is a part of Remedial Alternatives 4A and 4B. It is an innovative in situ treatment technology which has the potential to provide the controlled removal of volatile organic compounds (VOCs) present in the soil. Although not originally considered by the California Department of Health Services (DHS), the lead agency for the RI/FS, the community recommended that this technology be included within the scope of the Feasibility Study. Volatile organic compounds are drawn out of the soil, captured in vapor extraction wells, and the collected air is passed through activated carbon adsorption units to remove the VOCs. Spent activated carbon and the adsorbed chemicals are taken off-site for destruction or disposal. The community views VGE as a controllable technology that will remove those contaminants that pose the greatest threat to the community. It of course has limitations in that it is applicable to volatile compounds only, and does not address the non-volatile organics and metals also found at the Stringfellow site.

(2) In Situ Soil Flushing

In situ soil flushing is used to follow VGE in Remedial Alternatives 4A and 4B for the removal of non-volatile, water-soluble contaminants such as p-CBSA, sulfate, nitrate, and to some extent metals. In theory, soil flushing might appear to meet the goal of significantly removing contaminants from the site; however, the degree of contaminant control using this technology is a major concern.

Soil flushing is simply a matter of increasing the amount of water that infiltrates the site and percolates through the contaminated soil. Essentially soil flushing accelerates the natural process of rainfall infiltration and inplace washing of soil into the underlying ground water system. In the Feasibility Study, the amount of time to clean the site by natural flushing of rainwater has been estimated to be over 400 years. This is clearly unacceptable to the community. With enhanced flushing at a rate 15 times the natural rainfall rate, the time to clean the site has been estimated in the Feasibility Study to reduce to approximately 60 years.

The concern with inplace soil flushing is the ability to control chemicals that are mobilized from the soil into the ground water. The level of concern increases with the amount of water applied to the site. The Stringfellow site has a long history of failed attempts to control off-site releases of chemicals into ground water. It is, therefore, understandable that the community views technologies that would intentionally flush chemicals from the site into ground water with some concern. The performance of any system to recapture these mobilized chemicals is uncertain at best, as a direct result of the fractured nature of the bedrock beneath the site. Absolute, total control and removal of these chemicals in such an environment would not be realistic or predictable and the actual chemical recapture efficiency may only be determined by operational scale tests of the system. This uncertainty with respect to the control of off-site releases into ground water is a serious concern that clearly diminishes the attractiveness of soil flushing to the community.

(3) Incineration

Incineration is a component of Remedial Alternatives 4B and 5 used for the removal of organic contaminants from the soil. Two variations of this technology are considered in the Feasibility Study, rotary kiln and electric infrared, both of which are capable of destroying the organics found on-site. The preferred choice, rotary kiln, is a proven technology which meets the goal of permanently removing a significant fraction of organic contaminants. There remains a concern, however, with regard to the control of contaminant losses from the system - that is, emissions of toxic metals, such as beryllium and mercury, and organic chemicals that form as products of incomplete combustion, such as dioxin. This is not addressed in the Feasibility Study, yet it poses a serious concern to the community because the area is located in an air quality sensitive basin. Thus, while incineration offers the permanent removal of a significant portion of contaminants, there is the potential that the emission of a significant portion of contaminants present at the site cannot be fully controlled.

(4) Chemical Stabilization

Chemical stabilization of the treated soil, which follows incineration in Remedial Alternatives 4B and 5, is included to immobilize the heavy metals that remain in the incinerated soil prior to redisposal on-site. Prior to redisposal the excavated area is to be lined with a composite liner to prevent contaminated ground water from re-contaminating clean soil. The surface will be provided with a multilayer cap to prevent infiltration. This approach, if successful, would immobilize all of the metal contaminants; however, it does nothing to remove these contaminants from the site, a major issue in gaining acceptance by the community. Furthermore, the long-term effectiveness of chemical stabilization in providing immobilization is also subject to uncertainty. The overriding concern would be long-term control of the release of these contaminants particularly in a catastrophic situation (e.g., an earthquake), or if the cap were to be damaged by extreme weather conditions, as has occurred in the past.

(5) Soil Washing

The previous technologies constitute fundamental components of the preferred choices of the DHS for cleaning up the Stringfellow site. Each of these technologies attempts to provide a permanent solution to the contamination problem at the Stringfellow site. However, based on the information provided in the Feasibility Study, there appear to be significant uncertainties as to how effective these technologies will be in controlling environmental releases either during or subsequent to their implementation. These uncertainties apply to each of the above technologies with the exception of vacuum gas extraction. Therefore, while it is recognized that one or some combination of these technologies, with improvements, may in the end provide the best level of control that is practicable, consideration should be given to technologies that avoid such uncertainties. In particular, I believe that soil washing, an alternative technology briefly considered during the later stages of the Feasibility Study, warrants further evaluation.

Consideration of soil washing came about late in the feasibility study and a laboratory treatability study was aborted before gathering much data. Based on a review of available information from the U.S. and Europe, the Feasibility Study concluded that perhaps only 50 percent of the soil (those soil particles down to approximately 60 microns) could be effectively cleaned and that there was not enough time to evaluate the process further. I believe that there is sufficient information available regarding a particular West German process to suggest that up to 90% of the soil (soil particles down to approximately 15 microns) could be cleaned and that additional time must be spent to evaluate more fully the potential of this technology.

Soil washing potentially has several advantages over incineration as a soil treatment technology.

- The portion of soil which is treated would not require further treatment, whereas all incinerated soil must be stabilized to immobilize metals which remain.
- The portion of soil which cannot be treated via soil washing and must be treated further (particles smaller than the lower limit of treatment), perhaps with chemical stabilization, could be much less than the quantity of soil currently expected to require stabilization.
- Emissions from the process can be controlled more easily and concerns relating to VOC emission could be eliminated if VGE were implemented prior to excavation of the contaminated soil.
- It would be much easier to permit and obtain local public approval for soil washing, since it would have minimal impact on the sensitive air quality basin and because control over the removed contaminants would be managed through either on-site treatment and disposal or by removal to an off-site facility.

In summary, a satisfactory solution to cleanup of the Stringfellow site can only be provided by a combination of technologies that reduces the source of continuing environmental contamination. The most desirable remedial alternative is one which provides controlled treatment and removal of chemicals and contaminated residuals. Vacuum gas extraction represents an efficient technology for the removal of VOCs, but other chemicals remain. A final solution, therefore, must be developed to provide efficient and controlled removal of the remaining contaminants. Given the drawbacks of the technologies included in the remedial alternatives of the Feasibility Study, soil washing should be given more detailed consideration as an alternative to the incineration and soil flushing approaches.

Respectfully submitted,

Joseph H Highland/bw

Joseph H. Highland, Ph.D.
Senior Vice President

JHH:srf
0458c
cc: L. Foster
P. Newman

Mr. **Brown**. Thank you very much, Dr. Highland.

Senator Presley.

Mr. Clute.

Mr. **Clute**. Dr. Highland, I appreciate your testimony and look forward to seeing your analysis of the technologies and I did note that you mentioned the Feasibility Study, no analysis of air emissions that would be involved with incineration, which I find to be far more than norm with incineration projects than otherwise; because people for whatever reason, just do not want to analyze their emissions and present them to the public and I look forward to yours. MR. Highland. Let me just clarify one thing.

What I tried to say was that there were emissions that would come out of any rotary kiln incineration unit. I think in fact, if you look at the FS, you will see that some consideration to that is given right in the document. Now, whether that is a complete enough analysis or not, is an issue we will deal with at the public hearings.

Mr. **Brown**. All right, Dr. Highland, I think that is enough for this morning. We appreciate your being here. I hope you keep up the good work you have been doing in helping out in the community and presenting adequate alternatives to some of the proposals that have come out of the contractors.

Mr. **Highland**. Thank you very much, sir.

Mr. **Brown**. And I am delighted that we are within ten minutes of being on schedule.

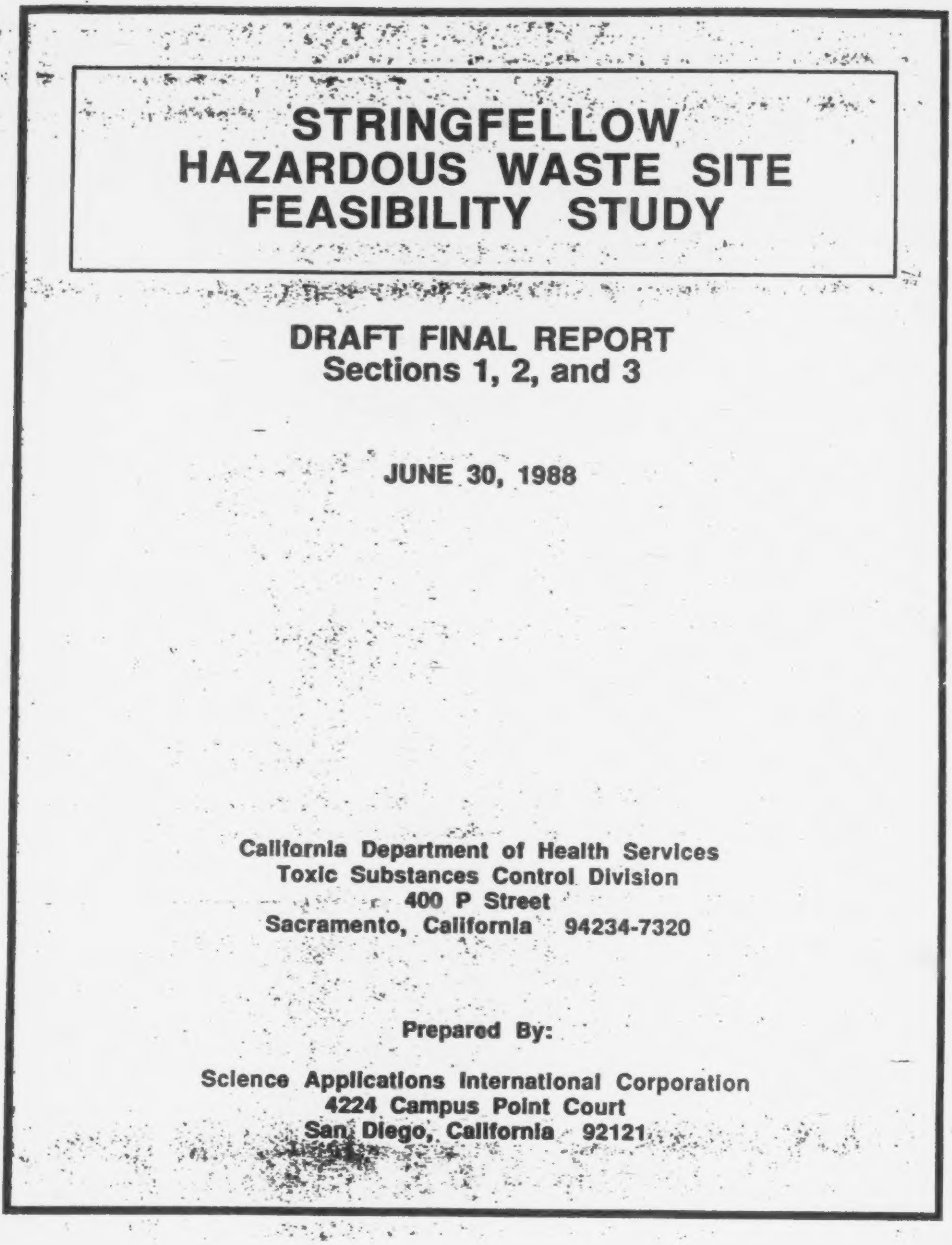
I want to thank the members of the community who came out this morning to participate in this and thank particularly our many distinguished witnesses who helped to make this an enlightening experience and none of the witnesses who are here today except Penny recall the last hearing that we had a few years back on this, which was marked by more heat than light, shall I say. And I think this hearing could be properly characterized as being extremely enlightening and the amount of the emotional tension has been reduced to a minimum.

I think that is because there is a sense, on all sides, that there is a good faith effort being made here. It is not without being subject to criticism, but it is a good faith effort and we think that that is a step in the right direction and I think all of us up here at this table will continue to exert all the pressure that we can to continue and accelerate that good faith effort that is being made and we hope we will not need to hold too many more of these hearings.

Thank you very much, Melba for being here with us also this morning. And with that the meeting will be adjourned.

[Whereupon, at 12:12 p.m., the subcommittee was adjourned.]

APPENDIX



STRINGFELLOW HAZARDOUS WASTE SITE FEASIBILITY STUDY

DRAFT FINAL REPORT
Sections 1, 2, and 3

JUNE 30, 1988

California Department of Health Services
Toxic Substances Control Division
400 P Street
Sacramento, California 94234-7320

Prepared By:

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1. INTRODUCTION AND BACKGROUND

1.1 PURPOSE OF REPORT

The Stringfellow Hazardous Waste Site was placed on the Superfund National Priority List (NPL) in 1982 as California's highest priority toxic waste site. As required by the Comprehensive Environment Response Compensation and Liability Act (CERCLA) and its recent renewal the Superfund Amendments and Reauthorization Act (SARA), the California Department of Health Services (DHS), with funding through a cooperative agreement with the U.S. Environmental Protection Agency (USEPA) Region IX, contracted with Science Applications International Corporation (SAIC) in March 1984 to comprehensively evaluate the Stringfellow Site, perform a remedial investigation (RI), and conduct a feasibility study (FS) to investigate the extent of contamination and evaluate methods for mitigating the spread of contaminants from the Site.

The RI involved a detailed characterization of the physical conditions present at the Site, and the extent and level of contamination from the Site. RI report results were published and released for public review in June 1987. The FS used the site-specific data and findings gathered during the RI to identify feasible cleanup technologies, to define alternative technologies for the final cleanup of the Site, and to evaluate the cost and effectiveness of the alternatives.

This FS report provides the detailed analysis of proposed Stringfellow Site remedial alternatives that passed through the initial screening process. The general purpose of the detailed analysis of alternatives is to provide information necessary to select a site remedy. The results of the detailed analysis will allow a remedial action to be selected in accordance with Section 121 of SARA, that fulfills the following criteria:

- Protect human health and the environment
- Achieve applicable or relevant and appropriate requirements (ARARs) or obtain a waiver
- Be cost-effective

- **Use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.**

This document is the culmination of a series of documents, including the RI, prior FS screening documents, and several treatability study reports. It has been prepared pursuant to CERCLA, as modified and supplemented by SARA.

The FS report is basically organized into five chapters. They are summarized in this technical summary and include:

1. Introduction and Background
2. Objectives of Stringfellow Site Remediation
3. Screening Technologies and Development of Remedial Alternatives
4. Detailed Evaluation of Remedial Alternatives (in this Technical Summary chapter titled "Detailed Description of Remedial Alternatives)
5. Summary Evaluation of Remedial Alternatives

In the main text of the FS report, Chapter 4 provided both detailed descriptions of each remedial alternative (RA) as well as effectiveness, feasibility, and cost evaluations for each remedial alternative (RA) separately. The RAs are then summarized and compared in Chapter 5. However, in this summary, Chapter 4 only describes the individual RAs, and Chapter 5 provides the effectiveness, feasibility, and cost evaluations in summary form for all the RAs. Refer to Chapter 4 of the FS for details of the individual RA evaluations.

1.2 STRINGFELLOW SITE BACKGROUND INFORMATION

1.2.1 Site Location

The Stringfellow Hazardous Waste Site is a former Class-I industrial waste disposal site located approximately 50 mi east of Los Angeles and near the community of Glen Avon. As shown in Figure S1-1, Glen Avon lies at the mouth of Pyrite Canyon approximately 1 mi southwest of the Site.

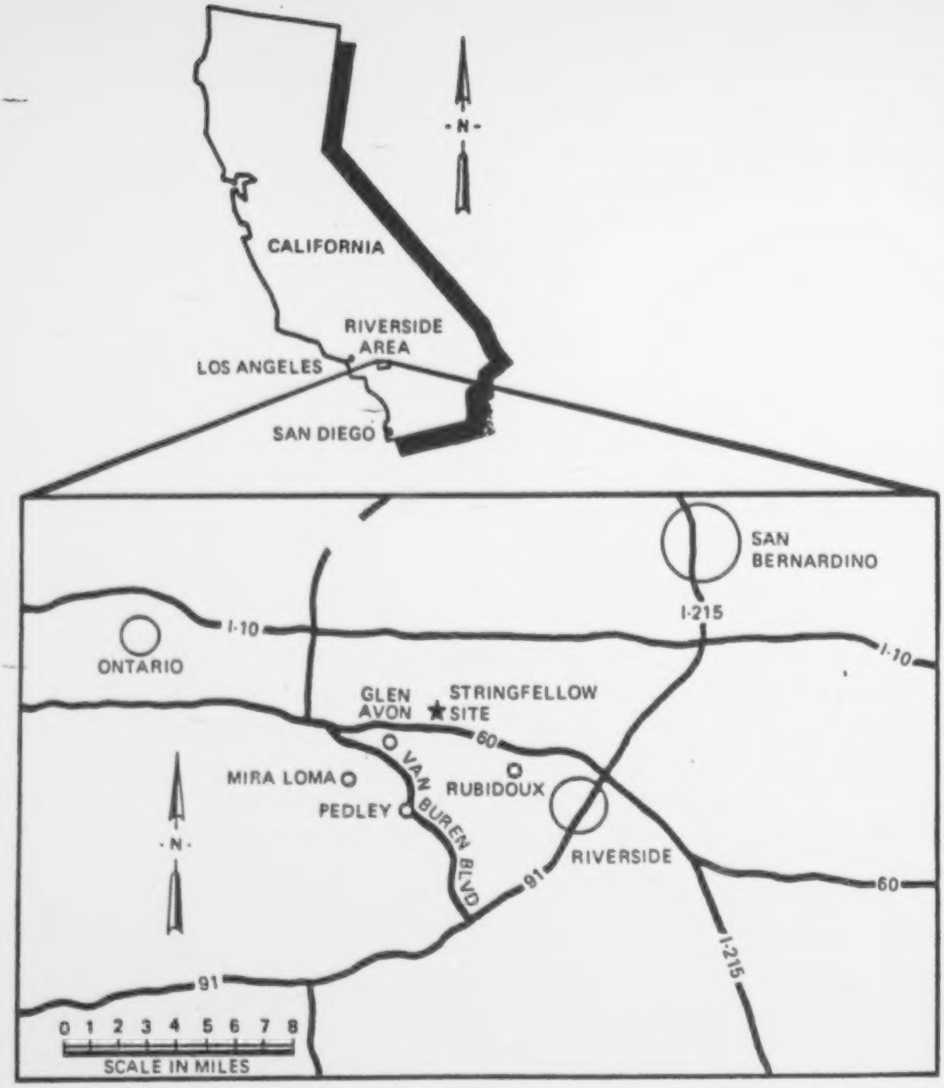

N
CALIFORNIA
RIVERSIDE AREA
LOS ANGELES
SAN DIEGO
SAN BERNARDINO
I-215
I-10
ONTARIO
I-10
GLEN AVON
STRINGFELLOW SITE
60
MIRA LOMA
VAN BUREN BLVD
RUBIDOUX
PEDLEY
RIVERSIDE
N
91
60
I-215
91
0 1 2 3 4 5 6 7 8
SCALE IN MILES

Figure S1-1. Location of the Stringfellow Waste Disposal Site

1.2.2 Site History

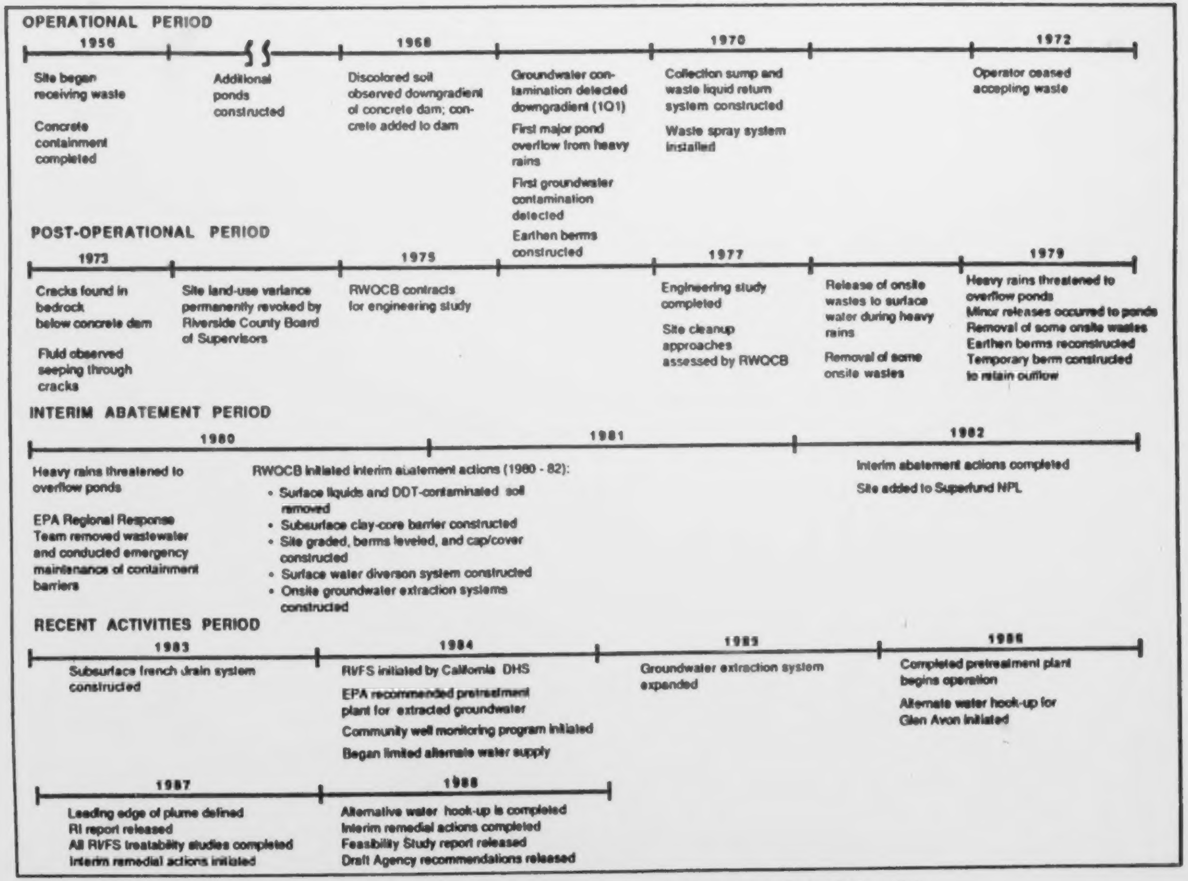
Historical activities at the Stringfellow Site fall into four time periods: (1) the operational period (1956 through 1972); (2) the post-operational period (1973 to 1980); (3) the interim abatement period (1980 to 1983); and (4) recent activities (1983 to present). Figure S1-3 summarizes key points in the Site's history.

After operating for 16 years as an industrial waste disposal facility, the Site discontinued business activities in November 1972. After a series of engineering assessments of closure options, an interim abatement effort was initiated in 1980. It consisted of removal of all surface ponds, construction of a subsurface barrier wall on the downgradient end of the Site, installation of a surface cap/cover and other drainage control features, and development of several on-site and downgradient groundwater extraction wells. The period prior to initiating interim abatement (1977-1980) was marked by 3 years of heavy rainfall that resulted in several contaminant overflows into the Glen Avon community. By the completion of interim abatement in 1982, the State Department of Health Services (DHS) had assumed responsibility for maintaining the Site and seeking final remediation through the Federal Superfund process.

At the present time, an active groundwater extraction effort is underway. Contaminated groundwater is collected from three onsite wells fed by onsite gravel drain systems, an interceptor well, a french drain situated immediately downgradient from the subsurface barrier, and seven mid-canyon wells. A pretreatment plant located in mid-canyon receives and treats the groundwater for metals and organics removal. The treated effluent is presently hauled by truck to the Santa Ana Regional Interceptor (SARI) line and discharged under a permit from the Santa Ana Water Project Authority (SAWPA). The SARI line presently carries municipal and industrial wastewater to Orange County, California, for treatment that is followed by direct discharge to the Pacific Ocean. Present abatement features at the Stringfellow Site are shown in Figure S1-4.

1.3 NATURE AND EXTENT OF CONTAMINATION PROBLEMS

During Site operations between 1956 and 1972, approximately 34 million gal of liquid wastes were disposed of in unlined ponds located throughout the



OPERATIONAL PERIOD

1956
Site began receiving waste
Concrete containment completed

Additional ponds constructed

1968
Discolored soil observed downgradient of concrete dam; concrete added to dam

Groundwater contamination detected downgradient (1Q1)
First major pond overflow from heavy rains
First groundwater contamination detected
Earthen berms constructed

1970
Collection sump and waste liquid return system constructed
Waste spray system installed

1972
Operator ceased accepting waste

POST-OPERATIONAL PERIOD

1973
Cracks found in bedrock below concrete dam
Fluid observed seeping through cracks

Site land-use variance permanently revoked by Riverside County Board of Supervisors

1975
RWOCB contracts for engineering study

1977
Engineering study completed
Site cleanup approaches assessed by RWOCB

Release of onsite wastes to surface water during heavy rains
Removal of some onsite wastes

1979
Heavy rains threatened to overflow ponds
Minor releases occurred to ponds
Removal of some onsite wastes
Earthen berms reconstructed
Temporary berm constructed to retain outflow

INTERIM ABATEMENT PERIOD

1980
Heavy rains threatened to overflow ponds

EPA Regional Response Team removed wastewater and conducted emergency maintenance of containment barriers

RWOCB initiated interim abatement actions (1980 - 82):
- Surface liquids and DDT-contaminated soil removed
- Subsurface clay-core barrier constructed
- Site graded, berms leveled, and cap/cover constructed
- Surface water diverson system constructed
- Onsite groundwater extraction systems constructed

1981

1982
Interim abatement actions completed
Site added to Superfund NPL

RECENT ACTIVITIES PERIOD

1983
Subsurface french drain system constructed

1984
RI/FS initiated by California DHS
EPA recommended pretreatment plant for extracted groundwater
Community well monitoring program initiated
Began limited alternate water supply

1985
Groundwater extraction system expanded

1986
Completed pretreatment plant begins operation
Alternate water hook-up for Glen Avon initiated

1987
Leading edge of plume defined
RI report released
All RI/FS treatability studies completed
Interim remedial actions initiated

1988
Alternative water hook-up is completed
Interim remedial actions completed
Feasibility Study report released
Draft Agency recommendations released

Figure S1-3. Historical Summary of Activities at the Stringfellow Site

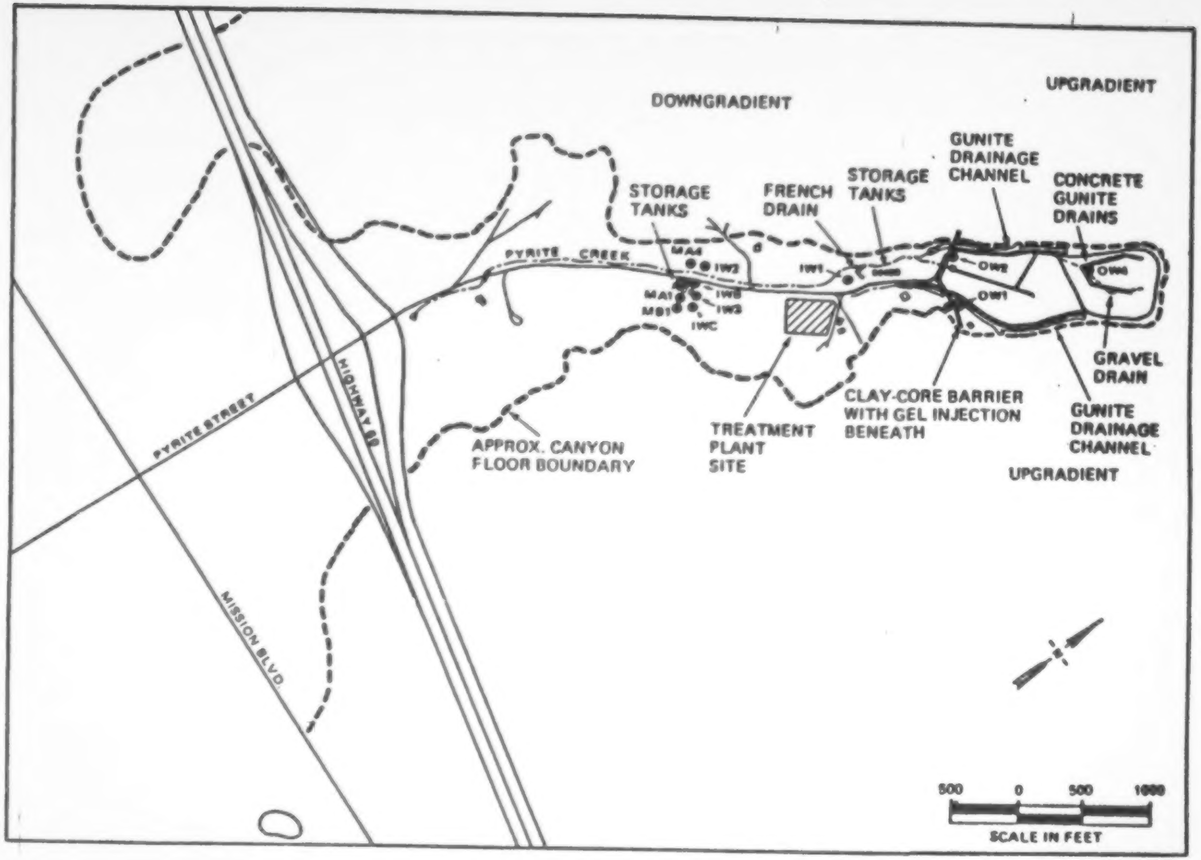

UPGRADIENT
DOWNGRADIENT
GUNITE DRAINAGE CHANNEL
CONCRETE GUNITE DRAINS
STORAGE TANKS
FRENCH DRAIN
STORAGE TANKS
PYRITE CREEK
MA4
IW2
IW1
OW2
OW1
OW4
MA1
MB1
IW5
IW3
IWC
GRAVEL DRAIN
CLAY-CORE BARRIER WITH GEL INJECTION BENEATH
GUNITE DRAINAGE CHANNEL
TREATMENT PLANT SITE
APPROX. CANYON FLOOR BOUNDARY
UPGRADIENT
PYRITE STREET
HIGHWAY 60
MISSION BLVD.
500
0
500
1000
SCALE IN FEET

Figure S1-4. Present Abatement Features at the Stringfellow Site (1986)

17-acre site area. Some of these wastes have migrated downward and entered the groundwater, mixed with clean groundwater entering the Site, and moved various distances downgradient, depending on the chemical and physical interactions with various geologic units. Most of the contamination is present in subsurface soil and groundwater onsite in Pyrite Canyon. Contamination also extends from the Site into the community of Glen Avon.

The chemical/physical processes that have occurred onsite and downgradient are complex. Site operations, chemical reactions, leachate formation and migration, abatement measures, infiltration and runoff, and volatilization processes have all affected the waste, producing heterogeneously contaminated soils and groundwater that have the potential to affect human health.

There are several transport routes, or pathways, that have released onsite contaminants into the environment. The principal pathways for contaminant transport are:

- Migration of residual onsite wastes downward into groundwater
- Lateral movement of contaminated groundwater downgradient.

Minor potential pathways for contaminant transport are:

- Transport of contaminated soil by wind and surface water
- Transport of soluble and particulate-bound contaminants by surface water.

During the Stringfellow Site's history, all of these pathways may have contributed to the release of contaminants from the Site, predominantly downgradient through Pyrite Canyon. Past releases of wastes from the Site into Pyrite Channel are known to have resulted in contamination of surface water and soils downgradient. At present, however, surface runoff and erosion of contaminated soil is minimal as the result of preventative interim control measures in place at the Site. Also, present air emissions from the Site are below standards criteria and regional background levels; there is apparently minimal, if any, residual air contamination emanating from the Site.

At present, the greatest risk to the Glen Avon population is from contaminated groundwater migrating downgradient from the Site in Pyrite Canyon and into the aquifer under Glen Avon. Although to date, no direct public water sources (i.e., private or service wells) have been found to be affected, the contaminated groundwater plume contains at least two organic contaminants, trichloroethylene (TCE) and chloroform, and two inorganic contaminants, nitrates and sulfates, that are above drinking water standards or guidelines.

2. OBJECTIVES OF STRINGFELLOW SITE REMEDIATION

2.1 OVERVIEW

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires that the selection of remedial actions at Superfund hazardous waste sites be protective of human health and the environment, cost-effective, and technologically and administratively feasible. Section 121 of CERCLA specifies that response action must be undertaken in compliance with Applicable or Relevant and Appropriate Requirements (ARARs) established in Federal and State environmental laws. Several different types of requirements are identified in which Superfund remedial actions must comply: (1) ambient or chemical-specific requirements; (2) action-specific requirements; and (3) location-specific requirements. Because situations at CERCLA sites are widely variant, EPA cannot categorically specify requirements that will be ARARs for every National Priority List (NPL) site. ARARs can only be identified on a site-specific basis (i.e., established in connection with the characteristics of the particular site, the chemicals present at the site, and the remedial alternatives suggested by the site circumstances). In this chapter of the FS, site-specific requirements are established for remediation of the Stringfellow Hazardous Waste Site.

2.2 THE USE OF ARARS AND THE DEVELOPMENT OF CLEANUP OBJECTIVES

In the FS process, the evaluation of remedial alternatives must consider effectiveness, implementability, and cost. Within the context of the effectiveness evaluation, chemical-specific ARARs assume major significance. A given remedial alternative must meet or exceed chemical-specific ARARs, or other risk-based levels established through a risk assessment when ARARs do not exist or are waived.

Chemical-specific ARARs serve two primary purposes: (1) to provide requirements that must be met by a selected remedial alternative (unless a waiver is obtained), and (2) to provide a basis for establishing appropriate cleanup levels. When an ARAR is available for all subject compounds of concern, and the ARARs are determined to be protective, these requirements become the chemical-specific cleanup goals. However, when ARARs are found not to be protective or are not available, the results of the risk assessment (i.e., health advisory levels) are used to establish the more stringent target cleanup goals.

Thus, the requirement that a remedial alternative meet chemical-specific ARARs does not ensure that the proposed alternative is protective, thereby potentially acceptable. This can be determined only by: (1) evaluating the combined carcinogenic risk associated with the ARAR limits for all chemicals at a given site (assuming additivity of effect in the absence of data on synergism or antagonism); (2) establishing that ARARs do not exceed EPA reference doses for noncarcinogenic effects and they are sufficiently protective when multiple chemicals are present; (3) determining whether environmental effects (in addition to human health considerations) are adequately addressed by the ARARs; and (4) evaluating whether the ARARs adequately cover all significant pathways of human exposure identified in the baseline risk assessment.

2.3 SELECTION OF INDICATOR COMPOUNDS AND IDENTIFICATION OF ARARS AT THE STRINGFELLOW WASTE SITE

In the Stringfellow FS report, ARARs are used in evaluating the effectiveness of remedial alternatives under investigation and in the development of allowable concentrations/target cleanup levels in environmental media. ARARs are supplemented with other criteria and guidelines to be considered (TBCs) and the results of public health risk assessment for each remedial alternative. The effectiveness evaluation of the remedial alternatives considers both short- and long-term protectiveness and potential health risks to workers as well as the general public.

At the Stringfellow Site, only chemical-specific and action-specific ARARs are relevant. No location-specific requirements (those that involve restrictions on how remedial activities are to be conducted in particular locations) apply to the Stringfellow Site.

Chemical-specific ARARs for water and air are presented in the following sections. Federal ARARs for soil have not been promulgated, and State of

California soil limits, although under development, have not been completed as of this date. The public health evaluation of each remedial alternative and the development of risk-based health advisory levels are presented in Chapter 5.

2.3.1 Chemical-Specific ARARs

2.3.1.1 ARARs and TBCs Requirements for Water

EPA's Groundwater Protection Strategy specifies that groundwater should be protected based on characteristics of vulnerability, use, and value. The policy establishes goals founded on "the highest beneficial use to which groundwater having significant water resources value can presently or potentially be put." The Stringfellow contaminated groundwater plume lies in an aquifier with Class I characteristics. Aquifiers with Class I characteristics are considered "Special Groundwaters" and include those that are highly vulnerable to contamination and those which are irreplaceable in that no reasonable alternative source of drinking water is available to substantial populations. The preference of the Superfund program is to restore and protect usable groundwater. Therefore, the selection of ARARs and cleanup objectives for the Stringfellow Site are based on the goal of the Superfund program "to protect public health and the environment by either (1) restoring potentially usable contaminated groundwater and protecting usable uncontaminated groundwater at levels that are safe for present and potential users and/or environmental receptors, or (2) preventing exposure to groundwater contaminated above health-based levels."

Monitoring data for groundwater at the Stringfellow Site are available for more than 50 parameters. It is both impractical and unnecessary to consider all parameters, so a subset of the contaminants found in Stream A groundwater (i.e., draining the Stringfellow Site proper) was selected as the basis for identifying water quality ARARs and for projecting associated risks to the public of the proposed remedial action alternatives.

Table S2-1 provides a list of the chemical-specific ARARs or TBC guidelines selected for use in evaluating groundwater remediation at the

Table S2-1. Selected Chemical-Specific ARARs or TBC Guidelines for Groundwater at the Stringfellow Hazardous Waste Site

Chemical	ARAR or TBC ($\mu g/l$)	Type of Requirement (Source)
Cadmium	10	MCL[a] (Federal)
Chromium (VI)	50	MCL (Federal)
Nickel	15.4	AWQC[b] (Federal)
Nitrate	10,000	MCL (Federal)
Sulfate	250,000	SMCL[c] (Federal)
2-Butanone	N/A	--
Chlorobenzene	30	AL[d] (DHS)
Chloroform	4.3	AAL[e] (DHS)
1,2-Dichlorobenzene	130	AL (DHS)
1,4-Dichlorobenzene	0.5	AL (DHS)
Methylene Chloride	40	AL (DHS)
Tetrachloroethylene	4	AL (DHS)
Trichloroethylene	5	MCL (Federal), AL (DHS)

[a] USEPA Primary Drinking Water Standard: Maximum Contaminant Levels

[b] Ambient Water Quality Criteria adjusted for evaluating levels of toxicants in drinking water

[c] Secondary Maximum Contaminant Level: Secondary Drinking Water Regulation (not a health-based standard or ARAR)

[d] Drinking Water Action Levels (ALs) developed by California DHS, Sanitary Engineering Branch. Levels projected to protect public drinking water systems.

[e] California Applied Action Levels (AALs) developed by California DHS, Sanitary Engineering Branch. Levels projected to protect public drinking water systems.

Stringfellow Site. USEPA Maximum Contaminant Levels (MCLs) were chosen as the ARAR unless the State requirements were more stringent. If neither an MCL nor a State requirement was available, the USEPA Ambient Water Quality Criteria (AWQC) adjusted for drinking water was selected. The USEPA Secondary Maximum Contaminant Level (SMCL) was chosen if no other guidance had been promulgated.

2.3.2 ARARs and TBC Requirements for Air

Federal ARARs

Potential ARARs were identified through a review of the Clean Air Act (CAA) and accompanying EPA regulations. The CAA establishes primary and secondary ambient air quality standards for protection of public health and welfare, and establishes emission limitations for certain hazardous pollutants. Table S2-2 lists national ambient air quality standards (NAAQSs) that have been promulgated for the following criteria pollutants: sulfur dioxide (SO_2); particulate matter below 10 μm in diameter (PM-10); carbon monoxide (CO); ozone; nitrogen dioxide (NO_2); and lead. The NAAQSs apply to the entire Nation under all circumstances, so in principle they are ARARs for all remedial action alternatives at Stringfellow.

The only other compound-specific potential ARARs for air are the National Emission Standards for Hazardous Air Pollutants (NESHAPs). EPA's authority to issue NESHAPs derives from Section 112 of the CAA. As of August 28, 1987, the only pollutants listed under Section 112 were asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride. Emission standards promulgated so far under Section 112 have been rather narrowly defined. They apply only to new and modified stationary sources, and for each pollutant and stationary source type only certain processes are regulated. Examination of the 11 standards promulgated as of July 1, 1986, determined that none of the 11 were applicable to remedial action alternatives at Stringfellow. However, standards for both beryllium and mercury would be considered relevant and appropriate if incineration of contaminated soils were to be employed at the Site as a remedial action.

Table S2-2. National and State Ambient Air Quality Standards (NAAQSs)
(April 1985)

Pollutant	National		State
	Primary	Secondary	
SO_2			
annual arithmetic mean	0.03 ppm		
max. 3-hr concentration		0.50 ppm	
max. 24-hr concentration	0.14 ppm		0.05 ppm
PM-10[a]			
annual geometric mean	50 $\mu g/m^3$		30 $\mu g/m^3$
max. 24-hr concentration	150 $\mu g/m^3$		50 $\mu g/m^3$
CO			
max. 1-hr concentration	35 ppm	35 ppm	20 ppm
max. 8-hr concentration	9.3 ppm	9.3 ppm	9.1 ppm
Ozone			
max. 1-hr concentration	0.12 ppm	0.12 ppm	0.10 ppm
NO_2			
annual arithmetic mean	0.05 ppm	0.05 ppm	
max. 1-hr concentration			0.25 ppm
Lead			
quarterly arithmetic mean	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$	
monthly arithmetic average			1.5 $\mu g/m^3$
Sulfate (Hi-Vol.)			
max. 24-hr concentration			25 $\mu g/m^3$
Hydrogen sulfide			
max. 1-hr concentration			0.03 ppm
Visibility			>10 miles when relative humidity is less than 70%
Vinyl Chloride			
24-hr average			10 ppb

[a] Particulate matter below 10 µm in diameter.

State of California ARARs

Table S2-2 also listed State ambient air quality standards. As with the NAAQSs, these standards apply throughout the State under all circumstances thus assuming the role of ARARs under CERCLA and SARA.

The California Air Resources Board (ARB) is currently reviewing a large number of substances for regulation under Assembly Bill 1807, known as the "Tanner Bill." As of May 1988, the Board had designated benzene, ethylene dibromide, ethylene dichloride, hexavalent chromium, dioxin and related compounds, asbestos, cadmium, and carbon tetrachloride, and ethylene oxide as such. Once a substance has been deemed a toxic air contaminant, the ARB prescribes control measures to be implemented by local agencies, including the South Coast Air Quality Management District (SCAQMD). As of December 1987, regulations had been promulgated for emissions of benzene from gasoline-dispensing operations and hexavalent chromium emissions from the electroplating industry. Neither of these regulations constitutes an ARAR under CERCLA and SARA.

California DHS has established applied action levels (AALs) for 15 air pollutants. The air-related AALs do not qualify as ambient air quality standards; rather, they act as thresholds for DHS decision-making processes, as outlined in the California Site Mitigation Decision Tree. Table S2-3 lists AALs for air pollutants that have been measured at the Site or that may be emitted during remedial activities.

Local ARARs

The western portion of Riverside County is within the jurisdiction of the South Coast Air Quality Management District (SCAQMD). Through Regulation X, the District has adopted all of the NESHAPs detailed above. Therefore, those compound-specific standards considered to be ARARs under Federal law would also be ARARs under local regulations.

Most of the potentially applicable SCAQMD regulations are process-specific and are discussed in Chapter 4 for each remedial action alternative being evaluated. However, the District's Regulation IV is specific to certain

Table S2-3. Air-Related Applied Action Levels

Substance	Applied Action Level (mg/m^3)	ppb[a]
Benzene	0.0032	1.0
Chloroform	0.00043	0.088
Ethylbenzene	0.14	32
Hexane	0.22	62
Toluene	0.20	53
1,1,1-Trichloroethane	0.31	67
Xylene (all isomers)	0.10	23

[a] Calculated for 25°C and 1 atm.

classes of compounds and applies to all processes not covered by other rules. Rules 401, 403, and 409 would be applicable to excavation and other activities that could disturb the soil cover at Stringfellow. Rule 402 (Nuisance) prohibits the discharge of "air contaminants or other material that cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public, or that endanger the comfort, repose, health, or safety of any such persons or the public." SCAQMD Regulation XIII (New Source Review) applies to any stationary source whose net emissions of "non-attainment air contaminants" exceed certain levels.

In December 1987, the District was considering, but had not yet promulgated, two regulations for control of toxic air contaminants. Rule 1401 sets limits for the maximum individual cancer risk and excess cancer cases from the cumulative impact of all permitted units at a given facility. If the maximum individual cancer risk is greater than or equal to 10^{-6}, then best available control technology for toxics (T-BACT) must be applied. If the maximum individual cancer risk exceeds 10^{-5} after application of T-BACT, then the permit application must be denied. Furthermore, if the excess cancer cases are greater than or equal to 0.5 for situations where the population is exposed to an individual cancer risk greater than 10^{-6}, then the permit must also be denied. Rule 223 specifies the methods to be used to determine the maximum individual cancer risk and the number of excess cancer cases.

2.4 ACTION-SPECIFIC ARARs

There are many action-specific ARARs that potentially impact the performance and design standards for the technologies comprising the remedial action alternatives. An example would be most of the provisions under the Hazardous Waste Control Act, California Administrative Code Title 2.2, Division 4, Chapter 30, Minimum Standards for Management of Hazardous and Extremely Hazardous Waste.

The Federal and State/local ARARs and TBCs that pertain to specific technologies proposed at Stringfellow are too numerous to present here. A comprehensive listing of pertinent ARARs and TBCs can be found in Chapter 2 of the main text. The actual determination of which requirements are applicable or relevant and appropriate is made by the lead agency (DHS) in consultation with the support agency (EPA).

2.5 CHEMICAL-SPECIFIC CLEANUP OBJECTIVES FOR THE STRINGFELLOW SITE AND THE CONCEPT OF GEOGRAPHIC ZONES

Cleanup objectives reflect site-specific conditions and depend on the particular contaminant present at or released from a site, as well as the unique geographic/environmental setting influencing the circumstances of exposure.

In this section of the FS, the concept of geographic zones as the basis for evaluating, selecting, and implementing remedial actions at the Stringfellow Site is broached, with the approach to establishing chemical-specific cleanup objectives based on the ARARs previously identified and risk-based health advisory levels emphasized.

2.5.1 Definition of Stringfellow Zones of Contamination

The Stringfellow Site and affected environments have been divided into four zones. These geographic regions are depicted in Figure S2-1, and described below:

Zone 1: Onsite/Upper Canyon

The onsite/upper canyon zone includes the entire northern section of Pyrite Canyon, from an imaginary line about 600 ft south of the subsurface barrier wall upgradient to the canyon crest. Beneath Zone 1, the groundwater is highly contaminated with a large number of organic and inorganic constituents. This zone contains all areas of known site-related soil contamination (surface and subsurface). Zone 1 has no residential or commercial population.

Zone 2: Mid-Canyon

The mid-canyon zone encompasses that portion of Pyrite Canyon extending from the southern edge of Zone 1 south to the existing mid-canyon extraction wells. This zone contains a heavily to moderately contaminated groundwater plume but no site-related surface soil contamination. The major contaminants are mobile organics (e.g., TCE), nitrates, sulfates, and chlorides. The groundwater contains virtually no heavy metals. Zone 2 has no residential population and very limited commercial use.

Zone 3: Lower Canyon

The lower canyon includes that portion of Pyrite Canyon from the mid-canyon extraction well area south to the proposed freeway (or lower canyon) extraction well barrier located on a transect just north of Hwy 60. This zone contains low-to-moderate groundwater contamination. Contaminants are mobile organics (e.g., TCE), sulfates, and nitrates. No soil (surface or subsurface) or surface water contamination related to the Site was found in this zone during the RI. Zone 3 contains only one private residence, two active business concerns (excluding the rock quarry located mid-canyon), and incorporates 80 to 100 acres of privately-owned land.

Zone 4: The Glen Avon Community

This zone includes the area from Hwy 60 south to the edges of the groundwater contaminant plume stemming from the Stringfellow Site. Groundwater contamination is the only known present impact from the Site, and is restricted to low levels of a small number of water soluble organic and inorganic contaminants (principally TCE, chloroform, nitrates, and sulfates). Present contaminant levels are unacceptably high to enable use of the affected portion of the aquifer as a potable water source. This affected area is highly populated, and contains as many as 20 private residences with operable water wells. Few have been found to be contaminated and none are used for drinking water at present.

2.5.2 Development of Cleanup Objectives

The objective in Zone 1 is to isolate and control the principal contamination source (i.e., the Stringfellow Site proper and the immediate environment downgradient). Contaminant migration through all media should be effectively stopped by the selected remedial alternative. In Zones 2 and 3, the mid-canyon remediation will focus on restoration of the contaminated groundwater beneath and downgradient of the Site to levels protective of human health, and on stopping the migration of presently contaminated groundwater into Zone 4. Zones 2 and 3 will also serve as groundwater monitoring areas to measure the effectiveness of upgradient (Zone 1) cleanup/isolation efforts. In

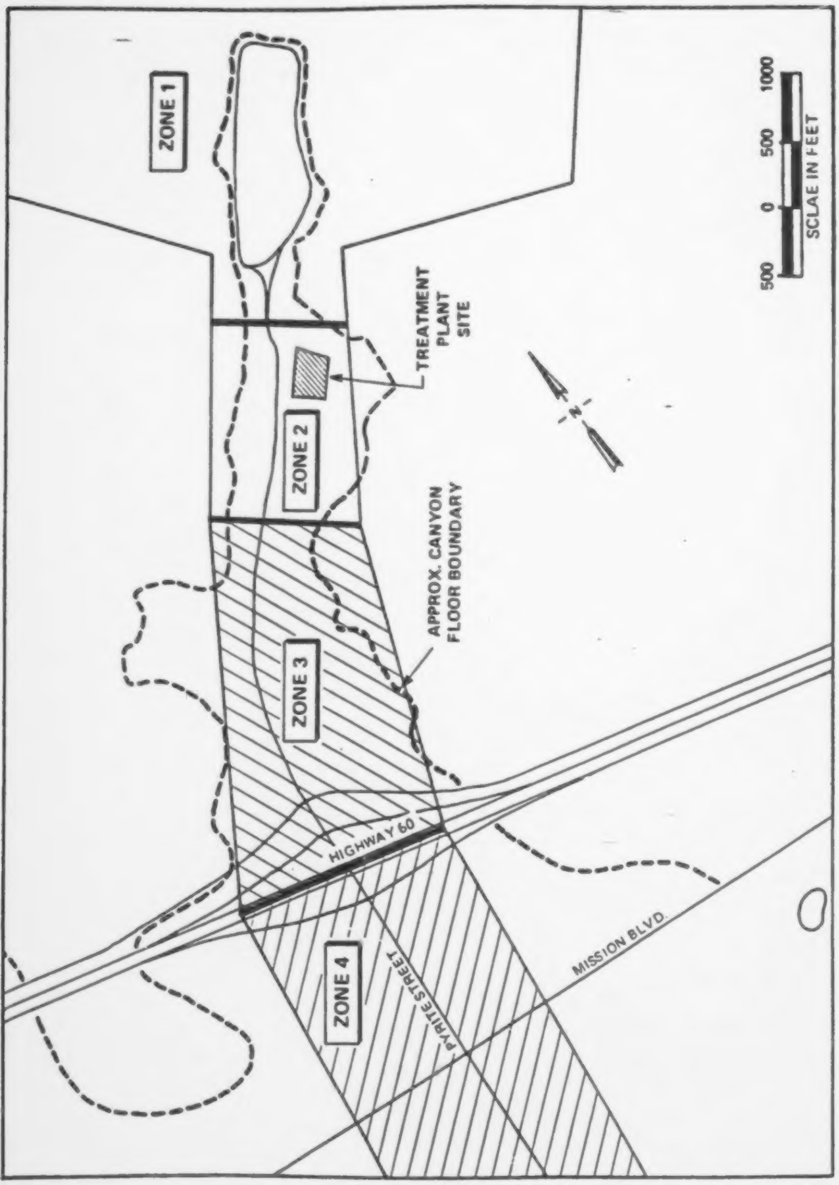

ZONE 1
ZONE 2
ZONE 3
ZONE 4
TREATMENT PLANT SITE
APPROX. CANYON FLOOR BOUNDARY
HIGHWAY 60
PYRITE STREET
MISSION BLVD.
N
500
0
500
1000
SCLAE IN FEET

Figure S2-1. Stringfellow Site Zones of Contamination Referred to in the Feasibility Study.

the community of Glen Avon (Zone 4), remediation objectives involve restoring contaminated groundwater to levels protective of human health, and stopping the further migration of the presently contaminated groundwater plume.

Long-term zone and chemical-specific cleanup objectives (i.e., target concentrations) will be established as follows:

- Identify the appropriate chemical-specific ARARs for each subject chemical
- Assess whether the combined carcinogenic risk associated with the ARAR limits is within acceptable range
- If the combined carcinogenic risk associated with ARAR limits is within acceptable range, then ARAR limits become target concentrations for site remediation
- If combined carcinogenic risk is unacceptable or if ARARs not available for all chemicals under evaluation, cleanup levels will be based on the target carcinogenic risk range established for each zone and each remedial alternative.

Target concentrations for carcinogenic groundwater contaminants at the Stringfellow Site have been developed by graphically generating curves of concentration/risk versus time from initiation of the remedial alternative. Graphs have been developed separately for each carcinogen and for combined excess carcinogenic risk across compounds (see Section 4.0 and Appendix B). A point has been identified on the combined risk graph where the total risk falls to the 10^{-6} level. Given this point in time, the associated groundwater concentrations for each of the subject chemicals may be identified for each zone, from the individual risk versus time graph. The concentrations for each subject chemical corresponding to a combined excess lifetime risk of 10^{-6} are presented in Table 2-4.

Table S2-4. Target Groundwater Concentrations Corresponding to a Combined Excess Lifetime Cancer Risk of 10^{-6}

Chemical	Concentrations ($\mu g/l$)[a]			
	Zone 1	Zone 2	Zone 3	Zone 4
Chloroform	8.2×10^{-2}	3.6×10^{-2}	9.1×10^{-3}	1.6×10^{-1}
Dichloromethane	7.1×10^{-1}	8.0×10^{-2}	0[b]	0[b]
Tetrachloroethylene	3.4×10^{-1}	5.7×10^{-1}	6.7×10^{-1}	3.8×10^{-2}
Trichloroethylene	7.2×10^{-1}	3.2×10^{-1}	9.2×10^{-1}	2.1

[a] Concentrations determined from total risk versus pore volume graphs Appendix B. Combined risk across all indicated chemicals is approximately 10^{-6} assuming ingestion of 2 l/day, for a 70 kg adult over a lifetime.

[b] Dichloromethane is not present in groundwaters of Zones 3 and 4.

3. SCREENING TECHNOLOGIES AND DEVELOPMENT OF REMEDIAL ALTERNATIVES

3.1 SCREENING OF TECHNOLOGIES

The identification and screening of technologies was the primary activity of Phase 1, development of alternatives. In prior FS screening efforts, 86 technologies were initially screened on the basis of technical factors and conditions. Over 50 percent were eliminated or were judged to have uncertain applicability. The remaining technologies were then further analysed and narrowed down to about 30, based on environmental, public health, institutional criteria, and costs. Table S3-1 provides a list of the remedial action technologies that survived the earlier FS screening phase. They are presented according to environmental media to be managed; also the more recent additions and deletions are included. The geographical zone of contamination for each applicable remedial technology is also identified.

3.2 SCREENING OF REMEDIAL ALTERNATIVES

The next step in the FS process involves assembling the selected technologies into remedial alternatives representing a range of treatment and containment combinations. The alternatives then undergo initial screening to qualify the list of potential alternatives that will be evaluated in detail.

Based on this approach, several remedial alternatives were developed in an earlier Task XI/XII draft report. They were:

- No action
- Onsite leachate management only (no dewatering)
- Dewatering only. Dewater the Site by means of an adit/gallery system or extraction wells, with recapping and surface drainage improvements
- Dewatering, excavation, treatment by neutralization, and RCRA cell construction. Dewater the Site, plus excavation of the digable contaminated soil, neutralization of the soil, and redeposition into onsite RCRA-type cells (this remedial alternative has since been eliminated)
- Dewatering, excavation, treatment by incineration and chemical stabilization, and redisposal onsite. Dewater the Site, with

Table S3-1. Remedial Action Technologies that Survived the Task XI/XII Screening Process

UNCONTAMINATED SURFACE WATER/GROUNDWATER MANAGEMENT	
Lowering of the Site Water Table (Dewatering)	
Zone 1	Dewatering and hydraulic isolation using onsite extraction wells placed from the ground surface
Zone 1	Dewatering and hydraulic isolation using a gallery drainage system (adit)
Surface Water Controls	
Zone 1	Multilayered cap system
Zone 1	Construction of stormwater channel at north end of Site (under design for construction in 1988)
Zone 1	Construction of stormwater channel at south end of Site (under design for construction in 1988)
WASTE AND CONTAMINATED SOIL CONTROL	
Remove Soil	
Zone 1	Excavation of digable contaminated soil from the Site and immediately below the barrier dam
Zone 1	Selective excavation of areas (hot spots) containing higher levels of contamination (added since Task XI/XII screening)
Soil Treatment	
Zone 1	Onsite thermal treatment of excavated contaminated soil
Zone 1	Chemical fixation, stabilization, or solidification of excavated contaminated soil or incineration ash
Zone 1	Neutralization of excavated contaminated soil (deleted since Task XI/XII screening)
Zone 1	In-situ soil-gas extraction (added since Task XI/XII screening)
Zone 1	In-situ soil flushing (added since Task XI/XII screening)
Zone 1	Ex-situ soil washing (late readdition, i.e., April 1988)

Table S3-1. Remedial Action Technologies that Survived the Task XI/XII Screening Process (Continued)

Soil/Sludge Disposal

Zone 1	Redispose excavated, treated soil onsite
All Zones	Truck sludges/solids and untreated soils to RCRA-permitted site

LEACHATE AND CONTAMINATED GROUNDWATER CONTROL

Groundwater Extraction

Zone 1	Onsite/upper mid-canyon contaminated groundwater and leachate extraction (partially in place at present)
Zone 2	Mid-canyon contaminated groundwater (plume) extraction (currently in place)
Zone 3	Lower canyon contaminated groundwater (plume) extraction (under design for construction in 1989)
Zone 4	Community contaminated groundwater (plume) extraction

Groundwater Treatment

Physical/Chemical

Zone 1	Chemical precipitation treatment of extracted groundwater
Zones 2,3,4	Air stripping treatment of extracted groundwater
All Zones	Granular activated carbon treatment of extracted groundwater
Zones 3,4	Reverse osmosis treatment of extracted groundwater

Biological

Zones 1,2	Biological treatment (Rotating Biological Contactor) of extracted groundwater (deleted since Task XI/XII screening)
Zones 1,2	Powdered Activated Carbon Treatment (PACT) process treatment of extracted groundwater

Table S3-1. Remedial Action Technologies that Survived the Task XI/XII Screening Process (Continued)

	Disposal of Adequately Treated Groundwater or Other Liquid Emissions
Zones 3,4	Surface discharge of treated groundwater
Zones 3,4	Reinjection of treated groundwater into aquifer
All Zones	Solar evaporation pond disposal of treated/untreated groundwater
All Zones	POTW sewer line disposal of treated groundwater
Zones 3,4	Mechanical evaporation (added since Task XI/XII screening)
	Ancillary
All Zones	Pipeline transport of extracted groundwater
All Zones	Tank storage/flow equalization of extracted groundwater

All remedial alternatives listed above also include extraction and treatment of the downgradient contaminated groundwater plume.

Based upon the RI report and additional technical and guidance information obtained since the Task XI/XII draft report was distributed, the FS team has deleted a remedial alternative, modified another, and added one. The remedial alternative that was eliminated employed dewatering, excavation, treatment by neutralization, and RCRA cell construction. As the study progressed, neutralization alone was deemed an inadequate treatment technology for contaminated excavated soil, as it provided insufficient remediation of organic contaminants.

Excavation and treatment by incineration has been modified to always include chemical fixation after incineration. This modification was made because treatability studies indicate that mobility/leachability of the heavy metals in the contaminated soil are not substantially reduced by incineration alone.

The addition of mixed treatment remedial alternatives has been made to provide onsite actions which reduce onsite source contamination at a cost less than that required for excavation and treatment of all the site digable soil.

It was determined that the following mixed treatment alternatives may be appropriate for application at Stringfellow. As such, they undergo detailed analysis in Chapters 4 and 5 and are considered for the final selection.

- In-Situ Flushing Plus In-Situ Soil-Gas Extraction (designated Remedial Alternative No. 4A)
- In-Situ Soil-Gas Extraction Plus Selective Excavation Plus In-Situ Flushing (designated Remedial Alternative No. 4B).

Both in-situ soil-gas extraction and in-situ soil flushing are new innovative technologies that have not been previously utilized at large sites similar to the Stringfellow Site. Prior to using these technologies at the

Stringfellow Site, pilot-scale testing would be necessary to further evaluate effectiveness and to determine design parameters.

Finally, soil washing was added for evaluation as a possible ex-situ soil treatment step in place of, or in addition to, incineration and chemical stabilization.

4. DETAILED DESCRIPTION OF REMEDIAL ALTERNATIVES UNDERGOING EVALUATION

In this section, the remedial alternatives (RAs) that survived the preliminary screening phase are described. As evident from a review of the RAs listed in previous Section 3.0, they become progressively more complex with a proportionate increase in cost. To minimize the length of Section 4, remedial technologies and actions common to several remedial alternatives are described only once, then referenced in the descriptions of the later remedial alternatives.

Some of the RAs described have several variations. These variations usually involve alternate technologies that could be used to accomplish the same purpose. For example, the dewatering process could employ either surface extraction wells or a subsurface drainage gallery tunnel (adit) system. At the FS Phase III stage of the evaluation, choosing between these technologies is not possible, so both are presented as potential variations. If dewatering of the Site is part of the selected remedial alternative, the decision regarding which dewatering system is used can be made at the conceptual design stage.

4.1 REMEDIAL ALTERNATIVE NO. 1 - THE NO-ACTION ALTERNATIVE

4.1.1 General Description of Remedial Alternative No. 1

RA No. 1, the No-action alternative, involves discontinuing Stream A and B groundwater extraction and treatment presently performed in the onsite area and in the mid-canyon. Also, no action to minimize the generation of contaminated leachate from the onsite area or any steps to cleanup or stop the further migration of the downgradient plume would be pursued. This RA was not carried through the detailed evaluation process, the reason being evident by referring to the Remedial Investigation (RI) baseline health evaluation, that emphasizes the impossibility of protecting public health and the environment.

This RA does not protect human health and the environment. Furthermore, legally applicable or relevant and appropriate requirements (ARARs) of Federal and State public health and/or environmental laws are not attained.

Grounds for invoking one of the six waivers provided in the Superfund Amendments and Reauthorization Act (SARA) do not exist.

This RA also achieves no reduction in the toxicity, mobility, or volume of the contaminants present at the Stringfellow Site. Furthermore, the volume of contaminated groundwater and soil increases with the spread of the contaminant plume.

4.2 REMEDIAL ALTERNATIVE NO. 2 - NATURAL FLUSHING OF THE ONSITE AREA PLUS DOWNGRADIENT PLUME MANAGEMENT

4.2.1 General Description of Remedial Alternative No. 2

This remedial alternative involves essentially a status quo for the onsite area and mid-canyon, combined with actions to control and clean up the downgradient plume below the mid-canyon. In the onsite area (Zone 1), this RA serves as a continuation of the present practice of extracting contaminated leachate using extraction wells located just north and south of the existing subterranean barrier dam. Other than future improved surface water drainage controls and an improved multilayered cap, no action is taken to minimize the future generation of contaminated groundwater from the Site. Water that percolates into the ground upgradient of the Site subsequently passes through the contaminated site material and commingles with the contaminate leachate. Groundwater is simply allowed to become contaminated, making the downgradient extraction wells near the barrier dam and in the mid-canyon responsible for intercepting and extracting the contaminated groundwater for the foreseeable future. The natural flushing action taking place eventually removes water-soluble contaminants over a long time period.

The existing mid-canyon extraction well system operates as a barrier against contaminant migration to the south. In this RA No. 2 no reinjection is done to accelerate the natural flushing cleanup of the canyon segment (Zone 2) between the onsite area and the mid-canyon extraction well barrier.

Downgradient from the mid-canyon extraction well barrier in lower Pyrite Canyon (Zone 3) and the community area south of Hwy 60 (Zone 4), this RA employs aggressive action to clean up the contaminated groundwater plume. These actions involve extraction of groundwater from the contaminated plume, extensive treatment of the extracted water to remove organic and inorganic contaminants, and reinjection of the treated water back into the aquifer.

4.2.2 Description of Onsite Actions Incorporated into this RA

The major onsite actions involved in this remedial alternative are:

- Construct surface runoff drainage channels at the north and south ends of the Site. Construction of these channels is projected for 1989 as an early implementation action.
- Regrade the onsite surface, install a new multilayered cap, and improve onsite surface drainage. The cap extends below the barrier dam and covers the contaminated soil in the upper mid-canyon.
- Continue present extraction of Stream A leachate in the vicinity of the barrier dam.
- Install additional leachate extraction wells in the gravel drain north of the subterranean barrier wall in an attempt to capture more of the leachate before it migrates offsite. This leachate is designated Stream A. For feasibility study purposes, the flow rate for Stream A is assumed to be 10 gpm.

The existing onsite barrier wall and extraction system (extraction wells OW-1, OW-4, OW-2, IW-1, and a French drain (see Figure S1-4) apparently intercepts and recovers 80-85 percent of the contaminated groundwater that would otherwise migrate offsite and downcanyon. The improvements made as part of this alternative could significantly improve the existing situation. A new multilayered cap would virtually eliminate the percolation of rainfall from directly above the Site, thereby slightly reducing the average quantity of leachate (about 1 gpm). Additional extraction wells in the french drain north of the barrier dam may provide improved interception of leachate, yielding a slight increase in Stream A volume.

If properly designed, the construction of a new multilayered surface cap and drainage channel improvements should eliminate the area as a source of surface water contamination.

4.2.3 Description of Mid-Canyon Extraction Wells

This remedial alternative anticipates continued operation of the mid-canyon extraction well barrier. In 1987, the mid-canyon extraction wells pumped about 7 million gal for an average of about 13.3 gpm (see Figure S1-4 for present mid-canyon extraction well configuration, i.e., MA-1, MB-1, MA-4, IW-2, IW-B, IW-3, IW-C). The flow volume, known as Stream B, fluctuates depending upon rainfall and other factors. For feasibility study purposes, the flow is assumed to average 20 gpm. It is estimated that the existing mid-canyon extraction wells are capturing virtually all of the contaminated groundwater flow through the mid-canyon area in the alluvium above the bedrock.

4.2.4 Description of Treatment Facilities for Extracted Onsite Leachate (Stream A) and Extracted Mid-Canyon Groundwater (Stream B)

Leachate extracted onsite (Stream A) and contaminated groundwater extracted from the mid-canyon (Stream B) are both presently treated at the existing mid-canyon pretreatment plant, which has been operating since 1985. In this RA, and all other RAs under consideration except the No-Action Alternative, this operation will continue.

Stream A is an acidic, complex mixture of heavy metal, organic, and inorganic contaminants. Sulfate concentrations are over 16,000 mg/l, and TCE almost reaches 5 mg/l. The pH is 3.5, causing the water to be very corrosive.

Stream B is far less contaminated than Stream A. Virtually no heavy metals are present. Among the organic contaminants, only the mobile, water soluble molecules (e.g., TCE) are found, but in concentrations much less than in Stream A.

The treatment processes necessary and feasible for any particular flow stream or combination of flow streams primarily depend upon the contaminant quality limitations imposed by the possible methods of disposal. For Streams A and B, the most feasible disposal method involves discharge to an industrial sewer. Since December 1985, treated effluent from the existing mid-canyon pretreatment plant has been discharged to the Santa Ana Regional Interceptor (SARI), operated by the Santa Ana Watershed Project Authority (SAWPA). The discharge requirements imposed by SAWPA on Stringfellow effluent require metals and organic contaminant reduction. This is achieved by the processes used at the existing mid-canyon treatment plant to treat Streams A and B. Stream A achieves metals removal treatment by chemical precipitation, unnecessary for Stream B because of its negligible metal concentrations. After metals removal treatment, Stream A is mixed with Stream B, and the combined stream passes through for activated carbon adsorption treatment. The treated effluent is then stored, monitored, and transported by tank truck about 15 mi to the POTW sewer (SARI line). Using this treatment process chain, the mid-canyon pretreatment plant has been achieving excellent results in treating Streams A and B to meet the effluent discharge requirements set by SAWPA for the SARI line.

4.2.5 Variations Considered in the Treatment and Disposal Facilities for Onsite Leachate (Stream A) and Extracted Mid-Canyon Groundwater (Stream B)

For economic reasons the feasibility study evaluated the use of other technologies to supplement or replace the processes presently employed to treat and dispose of Streams A and B. These replacement technologies create slight variations in the RA. Decisions between variations can be made later in the design phase, after the basic RA has been selected for use at the Stringfellow Site. A summary of variation evaluation follows:

- Addition of Rotating Biological Contactors to Treat Streams A and B was found not economically feasible.

- Use of a PACT System in Place of Granular Activated Carbon Beds was found to be not economically feasible.

- Use of Air Stripping Towers to Treat Stream B is only marginally economically feasible.

- Use of Solar Evaporation Ponds to Dispose of Streams A and B Combined was found to be more costly and less acceptable to local citizens than disposal to the industrial sewer.

- Use of a Force Main to Transport Stringfellow Effluent to the POTW Sewer (SARI) was found to be economically feasible when all anticipated Stringfellow Site effluents are combined. For feasibility study purposes, the basic treatment disposal variations will include pipeline transport of various Stringfellow effluents to the industrial sewer instead of tank truck transport.

4.2.6 Description of Lower Canyon Extraction Well Barrier

All remedial alternatives include the operation of an extraction well barrier in the lower canyon north of Hwy 60 at the south end of Zone 3. Figure S4-1 shows the approximate location of the lower canyon extraction wells. This early implementation action is presently under design and planned for construction in 1989.

Essentially, the current project involves the construction of at least five extraction wells at the lower end of Pyrite Canyon to intercept groundwater in the alluvium before it enters the Glen Avon community. The captured groundwater (Stream C) will be temporarily stored in tanks at the wellheads, then pumped in a pipeline along Pyrite St. north to the mid-canyon pretreatment plant. At the pretreatment plant, the groundwater will be treated with Streams A and B at the existing carbon adsorption units. An average Stream C flow from this extraction well barrier is estimated at 30 gpm, with a range of perhaps 15 to 60 gpm.

The actual characteristics of the extracted water will be revealed only after an extended period of operational pumping. It is expected that metals will be essentially nondetectable, and major organic priority pollutant contaminants will include TCE and chloroform. Nitrates and sulfates will be the major inorganic contaminants.

The objective of this early implementation action is to intercept the contaminated groundwater plume and prevent further contamination of the groundwater resources downgradient in the community area below Hwy 60. Construction should occur in 1989. When the selected RA is implemented, the following changes may occur:

- Stream C may be combined with Stream D (groundwater extracted from the community) for treatment and disposal. Stream D treatment is discussed in the following sections.
- A system of reinjection wells may be added to Zone 3 to accelerate cleanup of the lower canyon contaminated plume. The reinjection wells would be supplemented by a few additional extraction wells in mid-zone. Stream C volume would increase to about 70 gpm.

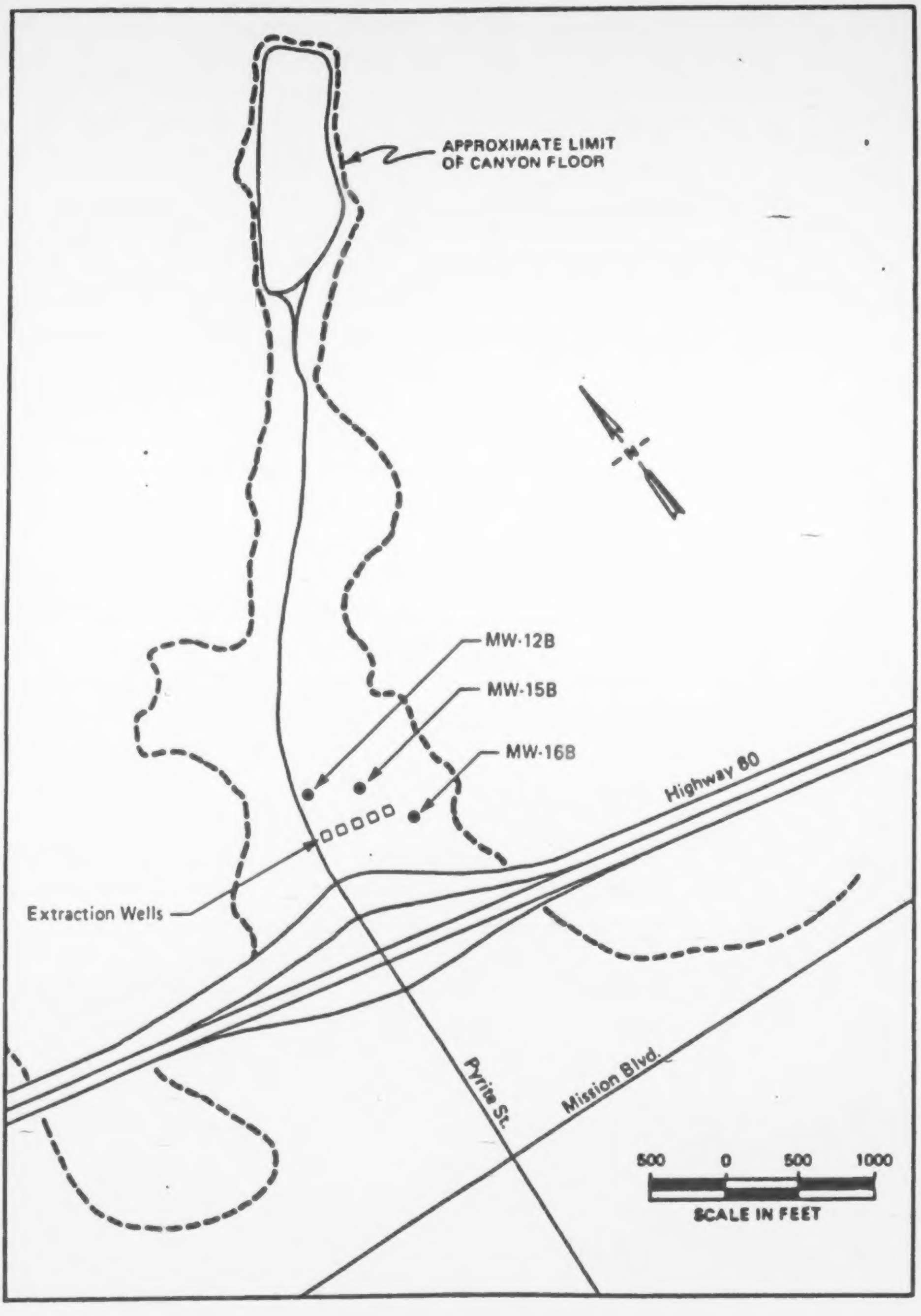

APPROXIMATE LIMIT OF CANYON FLOOR
MW-12B
MW-15B
MW-16B
Highway 60
Extraction Wells
Pyrite St.
Mission Blvd.
500 0 500 1000
SCALE IN FEET

Figure S4-1. Proposed Location of the Lower Canyon Extraction Wells

For the purposes of this feasibility study, both of the above changes are assumed to be in effect for all RAs.

4.2.7 Description of Community Extraction Well Barrier

All remedial alternatives include the installation and operation of an extraction well field in the community of Glen Avon (Zone 4). The strategies for cleaning up the community plume all involve extracting contaminated water and replacing the extracted water with clean water on a continuous basis. The clean water source could be either natural recharge from the surrounding aquifer, or natural recharge supplemented by reinjection of treated groundwater.

The extraction wells and reinjection wells, if used, would be located and operated with the intent of hydrogeologically keeping the existing contaminated groundwater plume contained, and over time cleaning up the plume within the contaminant boundaries. A closed system would be sought in which contaminated groundwater did not escape the boundaries of the plume and the groundwater flow is always from the less contaminated groundwater toward the more contaminated groundwater.

Groundwater extraction wells could be located at or near the locations shown in Figure S4-2. The selected cleanup strategy would employ approximately eight extraction wells spaced along the centerline of the plume. In all likelihood, the wells would be placed within existing street right-of-ways in underground vaults to minimize aboveground obstructions, unsightliness, and noise nuisances.

Extraction of contaminated groundwater both with and without reinjection of treated water was examined to determine a cleanup plan that maximized production rates and minimized cleanup time. The resultant plan uses eight production wells spaced at 800 to 900 ft apart along the centerline of the community plume (Figure S4-2). When no reinjection is done, the estimated average capacity of each well is 120 gpm and the total production capacity is a maximum of about 960 gpm.

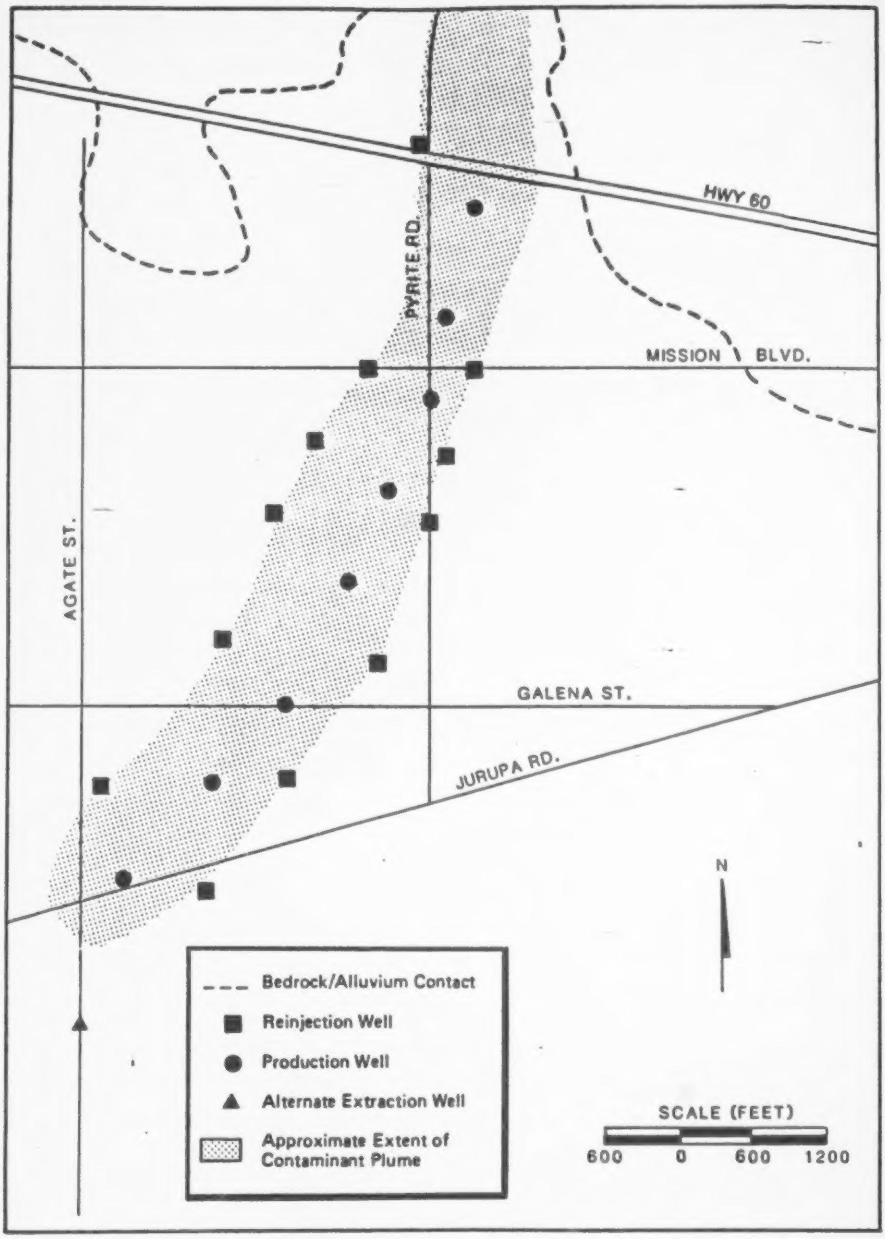

HWY 60
PYRITE RD.
MISSION BLVD.
AGATE ST.
GALENA ST.
JURUPA RD.
N
Bedrock/Alluvium Contact
Reinjection Well
Production Well
Alternate Extraction Well
Approximate Extent of Contaminant Plume
SCALE (FEET)
600
0
600
1200

Figure S4-2. Conceptual Layout of Community Extraction/Reinjection Wells Using Plan 1 Rapid Cleanup with Reinjection

Contaminant concentrations in the downgradient (southerly) areas are substantially lower than in the upgradient areas of the community. Concentrations in the southern parts of the plume will decrease to the water quality objectives sooner than concentrations near Hwy 60, allowing some production wells to be shut down. To accelerate cleanup, as downgradient production wells are shut down, additional upgradient wells can be added, decreasing the time necessary to flush the contaminants through the system.

The second plume cleanup plan in the community involves the installation of 13 reinjection wells along the periphery of the plume (see Figure S4-2). The reinjection wells would reinject highly treated groundwater back into the aquifer in a closed loop system. The volume of reinjected water would be about 700 gpm. Under an extraction plus reinjection scenario, the extraction wells would produce a maximum of approximately 1160 gpm, or about 150 gpm per well.

Each of the extraction well locations would be connected to a buried water pipe with a diameter of 4 to 8 in. Pipelines would be at depths and alignments to prevent the possibility of cross-contamination between untreated groundwater, local water supply lines, and local sewer lines. Extracted water would be conveyed to interim storage tanks located north of Hwy 60 near Pyrite Rd. A pump station would then convey the Stream D water through a 10 in diameter force main about 3000 ft long to the mid-canyon pretreatment plant. This pipe could also carry lower canyon water (Stream C).

4.2.8 Description of Treatment and Disposal Facilities for Lower Canyon (Stream C) and Community (Stream D) Extracted Groundwater

As shown in Figure S4-3, the water extracted from the community plume may or may not be treated. If the cleanup plan without reinjection is selected, then the extracted water would be discharged to an industrial sewer instead of reinjected at the periphery of the community plume. Treatment of the extracted groundwater from the community would not be necessary if the extracted water is discharged to an industrial sewer (e.g., the SARI line) via a pipeline of approximately 15 mi. The chemical quality of the extracted water would be expected to be within the present quality limits of the industrial sewer

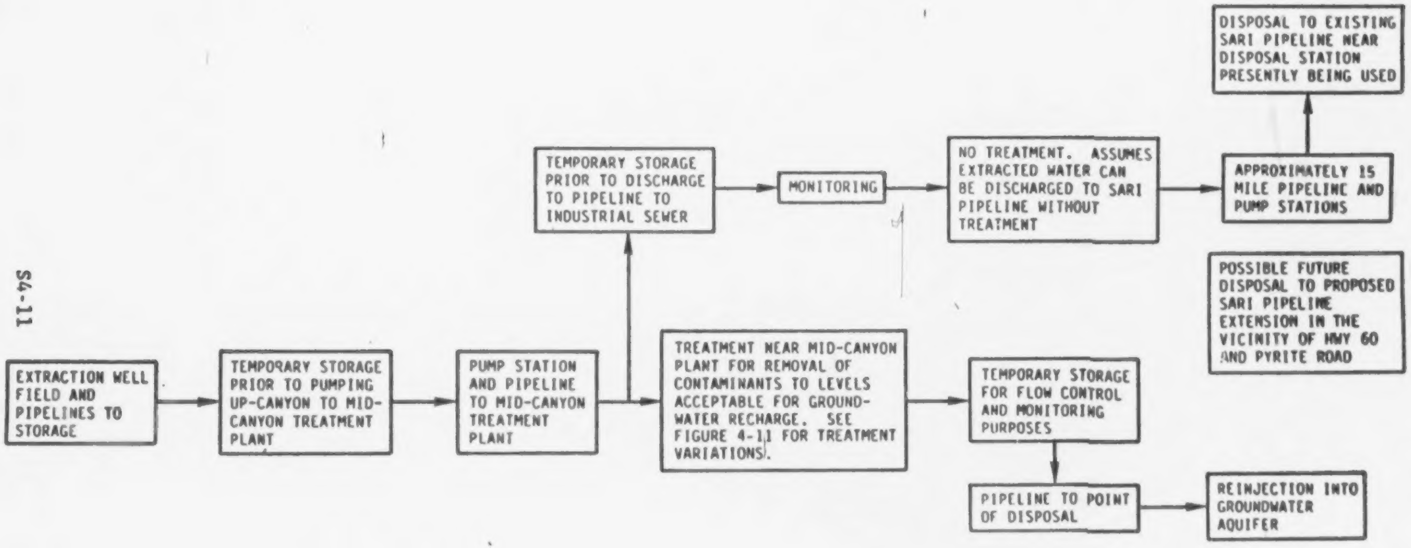

EXTRACTION WELL FIELD AND PIPELINES TO STORAGE
TEMPORARY STORAGE PRIOR TO PUMPING UP-CANYON TO MID-CANYON TREATMENT PLANT
PUMP STATION AND PIPELINE TO MID-CANYON TREATMENT PLANT
TEMPORARY STORAGE PRIOR TO DISCHARGE TO PIPELINE TO INDUSTRIAL SEWER
MONITORING
NO TREATMENT. ASSUMES EXTRACTED WATER CAN BE DISCHARGED TO SARI PIPELINE WITHOUT TREATMENT
APPROXIMATELY 15 MILE PIPELINE AND PUMP STATIONS
DISPOSAL TO EXISTING SARI PIPELINE NEAR DISPOSAL STATION PRESENTLY BEING USED
POSSIBLE FUTURE DISPOSAL TO PROPOSED SARI PIPELINE EXTENSION IN THE VICINITY OF HWY 60 AND PYRITE ROAD
TREATMENT NEAR MID-CANYON PLANT FOR REMOVAL OF CONTAMINANTS TO LEVELS ACCEPTABLE FOR GROUND-WATER RECHARGE. SEE FIGURE 4-11 FOR TREATMENT VARIATIONS.
TEMPORARY STORAGE FOR FLOW CONTROL AND MONITORING PURPOSES
PIPELINE TO POINT OF DISPOSAL
REINJECTION INTO GROUNDWATER AQUIFER

Figure S4-3. Flow Diagram of Various Methods to Manage Contaminated Groundwater from a Community Extraction Well System

discharge permit in terms of contaminant concentration. However, the present discharge permit to the SARI line industrial sewer stipulates a maximum volume of 187,000 gal/day. The permit would have to be modified to allow discharge of approximately 1.7 MGD generated by cleanup of the community plume without reinjection.

Treatment of the extracted groundwater will be necessary if the disposal method selected requires that the water disposed of has chemical contaminant levels lower than the levels in the raw water. This would apply if the final disposal method involves reinjection into the aquifer in the community. Figure S4-3 shows a schematic flow diagram of the treatment process that the raw water could undergo to make it of suitable quality to reinject. The treatment process includes the following consecutive units:

- Raw water storage and flow equalization tanks
- Treatment to remove organic contaminants, involving either air stripping or granular activated carbon beds
- Mixed media filtration to protect reverse osmosis (RO) units
- Reverse osmosis to remove inorganic contaminants
- Treated water storage and monitoring
- Treated water reinjected into groundwater aquifer.

Sidestream and residual management in the basic treatment process depicted in Figure S4-4 is as follows:

- Mixed media filtration backwash is added to the Stream A flow into the existing mid-canyon pretreatment plant for chemical precipitation treatment.
- Spent granular activated carbon, if used, is the responsibility of the carbon supplier and is shipped offsite for regeneration or disposal at an approved facility.
- The management of the brine concentrate from RO treatment assumes major significance. This volume is estimated to be 40 percent of the water volume entering the RO unit (i.e., the recovery rate is 60 percent), or about 500 gpm. The simplest method for disposing of this RO concentrate is to provide temporary storage and

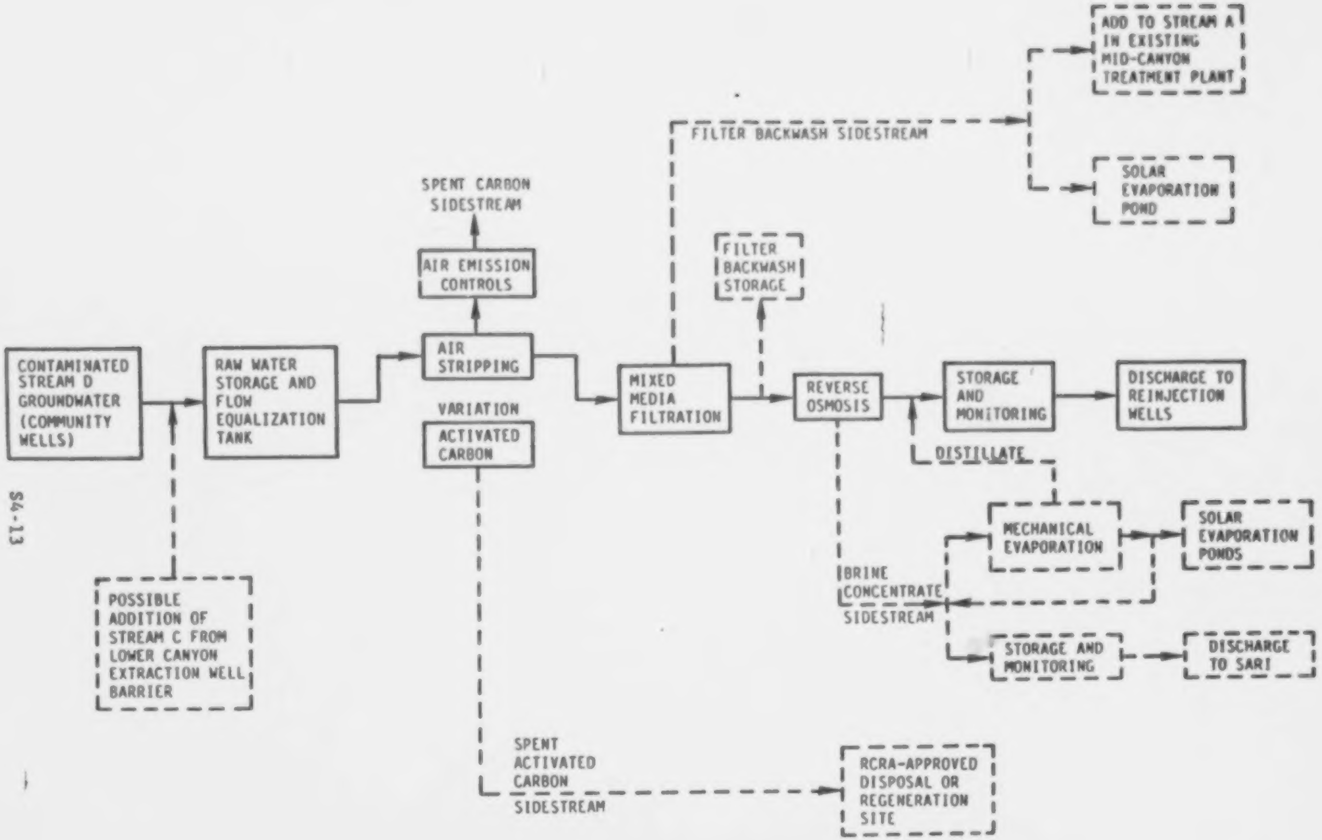

CONTAMINATED STREAM D GROUNDWATER (COMMUNITY WELLS)
POSSIBLE ADDITION OF STREAM C FROM LOWER CANYON EXTRACTION WELL BARRIER
RAW WATER STORAGE AND FLOW EQUALIZATION TANK
SPENT CARBON SIDESTREAM
AIR EMISSION CONTROLS
AIR STRIPPING
VARIATION
ACTIVATED CARBON
SPENT ACTIVATED CARBON SIDESTREAM
RCRA-APPROVED DISPOSAL OR REGENERATION SITE
MIXED MEDIA FILTRATION
FILTER BACKWASH SIDESTREAM
ADD TO STREAM A IN EXISTING MID-CANYON TREATMENT PLANT
SOLAR EVAPORATION POND
FILTER BACKWASH STORAGE
REVERSE OSMOSIS
STORAGE AND MONITORING
DISCHARGE TO REINJECTION WELLS
DISTILLATE
BRINE CONCENTRATE SIDESTREAM
MECHANICAL EVAPORATION
SOLAR EVAPORATION PONDS
STORAGE AND MONITORING
DISCHARGE TO SARI

Figure S4-4. Schematic Flow Diagram of Technology Combinations for the Treatment and Disposal of Extracted Community Groundwater (Stream D), Possibly Combined with Lower Canyon Extracted Groundwater (Stream C)

monitoring followed by disposal to the industrial sewer via pipeline. Treatment should not be required, because the organic contaminants were removed prior to RO treatment; none of the inorganics should act as a constraint to industrial sewer disposal.

- **If, for some reason, the RO brine concentrate cannot be disposed into an industrial sewer, the only disposal alternative available is evaporation ponds. Mechanical evaporators could be used to reduce the brine volume to a manageable quantity of 20 to 25 gpm.**

The basic treatment process summarized above and shown in Figure S4-4 should be capable of producing an effluent of very high quality for reinjection into the aquifer.

The treatment facility contemplated would be capable of treating approximately 1.5 MGD, roughly 10 times the capacity of the existing mid-canyon pretreatment plant. The new facility would probably be built in the mid-canyon area as an expansion or addition to the existing mid-canyon pretreatment plant.

4.2.9 Description of Variations Considered in the Treatment and Disposal Facilities for Extracted Community Groundwater (Stream D) and Extracted Lower Canyon Groundwater (Stream C)

The feasibility study evaluated the use of other technologies as alternatives for the basic unit process chain described in Section 4.2.8. These alternative technologies would create slight variations in the remedial alternative. Decisions between variations can be made later in the design process, after the basic RA for use at the Stringfellow Site has been selected. The variations evaluated are discussed in the following sections.

4.2.9.1 Substitution of Granular Activated Carbon Instead of Air Stripping Towers for Organics Removal From Streams C and D

Granular activated carbon contactors could be used instead of air stripping towers to remove organics from the water to be treated. Air stripping has a lower operating cost; however, air stripping removes only the volatile organics, not the nonvolatile organics. Nonvolatile organic chemicals that could pose a health hazard have not been identified in Streams C and D. Yet, the remote possibility that such nonvolatile organic compounds could be identified in Streams C and D in the future exists. Activated carbon would then be preferable over air stripping.

Onsite regeneration of spent activated carbon is not planned. The spent carbon would be collected by the vendor and shipped to an approved remote site for regeneration. At a use rate of 1 to 2 lb/1000 gal, a total of 331 to 662 tons of carbon would be used annually. By comparison, the air stripping facility air emissions vapor phase carbon adsorption units are estimated to use only about 20 to 30 tons of carbon a year. This difference in carbon use stems from the fact that granular activated carbon treatment removes all the organics, while the air stripping tower removes only the volatile organics, which constitute only a small fraction by weight (1 to 2 percent) of the total organic content. Also, vapor phase adsorption is more efficient. The variance in carbon use accounts for most of the difference in annual operating cost.

4.2.9.2 Substitution of Mechanical Evaporation and Solar Evaporation Ponds for Pipeline Transport and Disposal to the Industrial Sewer

As shown in Figure S4-4, the reverse osmosis (RO) concentrate flow of about 500 gpm could be concentrated further in a mechanical evaporator down to about 25 gpm, with the 25 gpm of highly concentrated brine then disposed of to a solar evaporation pond or to an industrial sewer. This scenario could be used instead of transporting the RO concentrate by a 15-mi pipeline sewer. Mechanical evaporation is very expensive and would be used as a substitute only if the industrial sewer could not accept the 500 gpm of RO brine, or if building the 15-mi pipeline from the Stringfellow Site to the industrial sewer proved infeasible.

A solar evaporation pond to dispose of 25 gpm of highly concentrated (about 10 percent total dissolved solids) brine solution would require about 9 acres of surface area and 14 acres of total area. Frequent dried solids removal and disposal would be necessary. The dried solids should not be hazardous and disposal to a Class II landfill should be possible.

Streams A and B could be combined with RO brine (Streams C and D) to be concentrated by mechanical evaporation prior to disposal. Although combined

Streams A and B have total dissolved solids and sulfate levels 2 to 3 times greater than the anticipated levels in the RO brine, Streams A and B will be significantly diluted by the greater volume of brine.

Note that evaluations of effectiveness, implementability, and costs for RAs will be summarized in later Section 5.0.

4.3 REMEDIAL ALTERNATIVE NO. 3 - ONSITE DEWATERING, EXTRACTION AND TREATMENT OF ONSITE LEACHATE, AND DOWNGRADIENT PLUME MANAGEMENT

4.3.1 General Description of Remedial Alternative No. 3

This RA involves lowering the water table in the onsite (Zone 1) area largely in order to isolate the contaminants in the soil from the natural groundwater flow. Minimizing contact between onsite contaminants and uncontaminated groundwater infiltrating into the area will greatly reduce the quantity of contaminants migrating downgradient from the Site. Essentially, the onsite element of this remedial alternative leaves contaminated soil/material in place and attempts to isolate it from contact with uncontaminated groundwater and surface water in perpetuity. The initial dewatering of the Site removes a portion of the existing onsite water soluble contamination mass. Improved surface-water drainage controls and a new multilayered cap would minimize the future percolation of surface water into the Site.

Downgradient (Zones 2, 3, and 4) groundwater plume cleanup actions in RA No. 3 are essentially the same as previously described for RA No. 2.

4.3.2 Description of Onsite Actions Incorporated in RA No. 3

The major onsite actions involved in this alternative are as follows:

- Construct runoff drainage channels at the north and south ends of the Site. Construction of these channels is projected for 1989 as an early implementation action.
- Dewater the onsite area by lowering the water table to approximately the top of the bedrock or a little below to ensure that the hydrologic zone of influence encompasses all the onsite contaminated groundwater. The contaminants thereby move towards an established sink. Dewatering could be implemented with vertical extraction wells drilled from the surface or with a subsurface

gallery drainage tunnel (adit). Both dewatering methods are evaluated with surface extraction wells considered the basic method and the drainage gallery tunnel as a variation.

- The contaminated leachate extracted during initial dewatering (about 14 million gal) over about a 1-year period would be treated as Stream A (maximum flow of 45 gpm) in the existing mid-canyon pretreatment plant.
- Regrade the onsite surface, install a new multilayered cap, and improve onsite surface drainage. The cap extends below the barrier dam and covers the contaminated soil in the upper mid-canyon.
- As part of the maintenance dewatering, intercept contaminated groundwater to the extent possible before it leaves the onsite area (operated in perpetuity).
- As part of the maintenance dewatering, intercept uncontaminated groundwater to the extent possible before it enters the contaminated material (operated in perpetuity).
- Provide treatment and disposal to the groundwater (Stream A) extracted during steady state conditions after initial dewatering is complete. Flow volume is anticipated to be 10 gpm.

This remedial alternative proposes to extract a major portion (about 14 million gal) of the contaminated groundwater that can be drained from beneath the Site. The groundwater table would be significantly lowered in perpetuity.

In this remedial alternative, the dewatering system is not intended to clean up the Site. The existing onsite contaminated soil and rock material would remain in place as would the residual fluids in the drained ground above the final water table. If an isolation strategy is selected, a dewatering system would be operated in perpetuity, along with other maintenance and monitoring facilities included in such a remedial approach.

4.3.3 Estimate of the Quantity and Quality of Groundwater Extracted from the Site During Dewatering

The quantity of water produced by the Site during dewatering is estimated at 14 million gal plus the volume of influx water, which is estimated at 8 gpm or about 4 million gal/year. Therefore, if dewatering requires 1 year, then the estimated volume of water extracted in that first year equals 14 million gal plus 4 million gal for a total of 18 million gal. To keep the Site dewatered in succeeding years, flow volume would only be about 4 million gal/year (i.e., enough withdrawal to equal the influx from outside the Site).

One must recognize that hydrogeology is not an exact science, and Stringfellow is a large, complex site. The above volume estimates could be wrong by 100 percent, and the actual volume extracted during initial dewatering could be as low as 10 million gal or as high as 40 million gal. Differences in actual volume will affect time to dewater, but otherwise should not significantly affect the dewatering system.

The quality of the water extracted will vary because of onsite contaminant heterogeneity. For feasibility study purposes, the quality of the extracted water is assumed to be initially equivalent to that of the leachate presently extracted from the Site (Stream A). As dewatering is continued, the quality of the extracted water would gradually improve as dilution occurs.

4.3.4 Description of the Surface Well Extraction System

The surface extraction well dewatering system would lower the water table in the onsite and upper mid-canyon areas.

The wells would not be able to separate contaminated groundwater from uncontaminated groundwater. Thus, all the extracted water would be contaminated. Under this scenario, it is estimated that 15 primary wells would be installed throughout the Site. Based upon the cumulative extraction rates of these wells and drawdown characteristics, an additional 16 wells could then be installed and tested, with some poor producers converted to monitoring stations. Based upon the estimates of well yields and spacings required by the rock structure and continuity of the fracture system, a total of 18 to 36 wells might be drilled.

For feasibility study purposes, the extraction wells are assumed to average 6 in diameter and be drilled to about 20 ft into the bedrock with wells averaging about 65 ft deep. Because of the low average production rates anticipated, double-pipe eductor pumps are suggested for pumping the water to the surface. Aboveground facilities would include pumps and appurtenances, piping, electrical, field storage tanks, controls, instrumentation, pump pads, etc. The conceptual design includes fiberglass reinforced plastic (FRP) tanks that provide 250,000 gal of contaminated water storage (4-day storage).

Extracted water would be limited to a maximum of about 45 gpm, which is the Stream A capacity of the existing mid-canyon pretreatment plant, if operated 7 days/week, 24 hr/day. At 45 gpm, the Site could theoretically be dewatered in slightly less than 1 year, if the volume estimates made earlier are accurate.

4.3.5 Description of the Gallery Drainage Tunnel Variation for Dewatering of the Onsite Area

The feasibility study evaluated the use of a gallery drainage tunnel (adit) system as an alternate to the use of surface extraction wells to dewater the onsite area.

The primary objective of the subsurface gallery drainage system would be to lower the water table of the onsite area and upper mid-canyon. In addition, the system would seek to intercept upgradient uncontaminated groundwater flowing toward the Site before contact with contaminated soil/groundwater, thereby resulting in a major long-term reduction in Stream A flow volume that requires treatment. The system is attractive for remedial alternatives where permanent dewatering is required (i.e., RA No. 3) or where the system will be used for a long time, as with in-situ flushing.

The drainage gallery system consists of a continuous tunnel 10 to 14 ft in diameter routed completely around the onsite area in an approximate oval of about 700 to 800 ft by 2000 ft. Two possible configurations were considered. If the tunnel is at about 970 ft elevation beneath the Site, it could daylight (portal) at the Stringfellow quarry. An alternative alignment at 950 ft elevation would daylight the tunnel at an elevation of 910 ft further down-canyon south of the Stringfellow quarry. A declining access tunnel (not shown) or a shaft (about 25 ft in diameter shown as Alternative 2) could substitute for a horizontal portal.

The tunnels would be constructed in bedrock below the peripheral to the disposal area, at depths ranging to 120 ft below land surface. In order to provide good rock conditions for safe support, cost-effective construction, and lack of toxic inflow, the tunnel would be situated mostly in competent bedrock below the valley walls. Two sets of drain holes would be drilled laterally out of the tunnel. One set would be directed "inward" toward and beneath the waste disposal area to drain contaminated groundwater; the other set would extend "outward" away from the waste and towards the canyon slopes where uncontaminated groundwater flowing toward the Site can be intercepted. Heavily contaminated water would be drained through the inward holes, with less contaminated water collected by the outward drain holes. The drainage hole array can be constructed with spacing and inclination selected to provide penetration of the maximum number of fractures to ensure water table decline.

The volume of water generated by the drainage tunnel would be controlled by use of valves on drainage hole nipples. For feasibility study estimating purposes, the maximum flow rate will be held to about 45 gpm. Drainage water volume (Stream A leachate) will range from 45 gpm during the initial drainage period to about 8 gpm after a year. For feasibility study purposes, an average flow of 10 gpm is used. Eventually, some portion of this flow can be separated as clean water.

4.3.6 Description of Downgradient Actions Incorporated in RA No. 3

With one exception, the downgradient actions in Zones 2, 3, and 4 included in RA No. 3 are exactly the same as those that were described previously for RA No. 2 in Sections 4.2.3 through 4.2.9. The exception pertains to the flow volume of Stream A. In RA No. 2, the flow volume of onsite leachate is estimated at 10 gpm from the outset; in RA No. 3, the initial year of dewatering is estimated to generate a flow volume of up to 45 gpm (existing plant capacity) of Stream A until the dewatering is complete. Maintenance of the dewatered condition is assumed to require 10 gpm of Stream A flow volume, the same as in RA No. 2.

Treating 45 gpm of Stream A at the existing mid-canyon pretreatment plant during the dewatering period requires full-time operation (i.e., 24 hr/day, 7 days/week). As detailed in Section 4.2.4, the metals precipitation unit includes two clarifiers, each with 25 gpm capacity. Ten percent downtime for maintenance is expected, so the effective full-time capacity is approximately 45 gpm. The carbon contactor units at the existing mid-canyon pretreatment plant have a design capacity of about 130 gpm, so a combined flow of 45 gpm of Stream A and 20 gpm of Stream B (65 gpm total) is well within the carbon treatment capacity.

4.4 REMEDIAL ALTERNATIVE NO. 4A - ONSITE DEWATERING, EXTRACTION AND TREATMENT OF ONSITE LEACHATE, SOIL-GAS EXTRACTION, IN-SITU FLUSHING, PLUS DOWNGRADIENT PLUME MANAGEMENT

4.4.1 General Description of Remedial Alternative No. 4A

After initial dewatering this remedial alternative accelerates the cleanup of the onsite (Zone 1) and mid-canyon (Zone 2) areas. Zone 1 cleanup is hastened by using soil-gas extraction as an in-situ means of largely removing volatile organics from contaminated soil above the saturated zone (water table), then using in-situ flushing of the contaminated soil to remove the remaining water soluble organics. Both the soil-gas extraction and in-situ flushing technologies are considered innovative, unproven technologies at a large, heterogeneous site such as Stringfellow. Therefore, if this RA is selected, it will be necessary to conduct field tests to verify the feasibility of one or both of these technologies. Only dewatering plus soil-gas extraction may be approved as initial actions, and judgment may be reserved on the more controversial soil-flushing technology pending results from implementation of the earlier technologies and the field testing.

As with all of the RAs, additions to the stormwater channels are included as an early implementation action. Downgradient in the lower canyon (Zone 3) and the community (Zone 4), the cleanup actions are the same as previously presented for RA Nos. 2 and 3.

4.4.2 Description of Onsite Actions Incorporated in this RA

The major onsite actions involved in this remedial alternative are as follows:

- **Construct surface runoff drainage channels at the north and south ends of the Site. Construction of these channels is projected for 1989 as an early implementation action.**

- Dewater the onsite area by lowering the water table to approximately the top of the bedrock. Surface extraction wells are considered the basic method and the drainage gallery tunnel a variation.

- The contaminated leachate extracted during initial dewatering (estimated at about 14 million gal over a 1-year period) would be treated as Stream A (maximum flow of 45 gpm) in the existing mid-canyon pretreatment plant.

- Provide treatment in the existing mid-canyon pretreatment plant and disposal of the groundwater extracted during steady state conditions after initial dewatering is complete. The flow volume of this Stream A leachate is estimated at 10 gpm.

- Implement in-situ soil-gas extraction in the onsite area over about a 2-year period, if field tests prove favorable.

- Implement in-situ soil flushing in the onsite area following soil-gas extraction.

The following sections present descriptions of the onsite remedial actions incorporated in this RA that were not covered earlier.

4.4.2.1 In-Situ Soil-Gas Extraction

In-situ soil-gas extraction involves a process whereby a vacuum (suction) is placed in wells in the ground above the lowered water table, forcing air to flow through the pore spaces of unsaturated contaminated soil. The moving air collects volatile organic vapors. The air can then be removed from the ground by suction, and the volatile compounds collected for disposal. At the Stringfellow Site, the process would be employed after use of a dewatering system that lowered the groundwater table. Dewatering would increase the volume of soil above the water table from which volatile compounds could be withdrawn. The portion of the volatile organics residing below the water table and capillary fringe would be largely unaffected by soil-gas extraction.

Volatile organic contaminants represent less than 1 percent by weight of the mass of contaminants present at the Stringfellow Site; however, the volatile organics are significant contaminants despite their low concentration.

Many volatile organics are very mobile in groundwater (e.g., TCE, chloroform), and are the major toxic organic contaminants found in the offsite downgradient contaminated groundwater plume. As the Site dewaters, volatile organics that are left in the vadose zone could be largely removed by a soil-gas extraction system. Once removed, these volatile organics would not be present in large quantities to contaminate the flushing water used in the in-situ soil flushing, significantly reducing in-situ flushing time.

The basic components of a soil-gas extraction system include the underground component consisting of wells inserted into the contaminated area that extract soil gases and vapors by vacuum pumping. The aboveground support equipment includes blowers, water/gas separators, and some means to manage the extracted gases and separated water. The suction element of the blowers attaches to the wells to pull out air. The extracted air contains both volatile organics and considerable moisture (water vapor). A water/gas separator is required to separate the moisture from the air.

Techniques used elsewhere for managing the extracted gases include thermal destruction, activated carbon adsorption, or atmospheric release without treatment. At the Stringfellow Site, vapor-phase activated carbon adsorption is chosen as the method for analysis purposes. The small volume of separated water from the water/gas separator would be conveyed to the mid-canyon pretreatment plant for treatment and disposal.

The design of soil-gas extraction systems is more an applied science at this early stage of technology development. Presumably, the extraction wells will have to be spaced at close intervals because of the low permeability of the alluvium fill. For analysis purposes, the soil-gas extraction wells are assumed to be installed at 30 ft spacing throughout the Site and average 50 ft deep. Given a 20-acre site and 30 ft spacing between wells, a total of about 970 soil-gas extraction wells would be required.

To complete the conceptual picture of a soil-gas extraction system at the Stringfellow Site, a provision for approximately 20 aboveground facilities (1 per acre) would be necessary, each of which incorporates blowers to create the vacuum, an air/water separator, a vapor-phase carbon adsorption unit, and required piping, appurtenances, controls, etc. The air suction flow generated averages an estimated 3000 cfm/acre.

In-situ soil-gas extraction could theoretically be applied to the Stringfellow Site. However, no soil-gas extraction projects were identified elsewhere that had applied the technique to a site having the heterogeneity, low permeability, variety of contaminants, low pH, and size of the Stringfellow Site. Obviously, appropriate field testing prior to selecting final design parameters must be conducted.

Once in place, the system should be relatively simple and reliable to operate. The vast number of wells, blowers, etc., would require the employment of a large number of operation and maintenance (O&M) workers. The volatile organic concentrations in the soil above the capillary fringe could conceivably be reduced to levels in the low ppb in about 1 to 2 years of operation after construction is completed.

4.4.2.2 In-Situ Soil Flushing

In-situ soil flushing involves a process in which water is introduced into contaminated soil and allowed to infiltrate the soil pore spaces. The percolating flushing water mobilizes water soluble contaminants and conveys them to extraction wells.

Approximately 17 gpm of flushing water would be continuously applied to the entire Site by means of a grid system of small-diameter perforated pipes laid in shallow trenches. The pipes would be on approximately 10 ft centers. Flushing water would percolate downward through the unsaturated zone until it reached the water table, with extraction wells withdrawing the leachate. Flushing is continuous (i.e., a constant rate of water applied and withdrawn).

The water used for flushing need not be drinking water quality; however, the best free water readily available should be sought. Water extracted from the groundwater plume in the community (Stream D) would be ideal.

The production wells used for the initial site dewatering earlier in this remedial alternative could be used to collect the contaminated flushing water. Since the proposed flushing process requires more intense control over the piezometry, more wells would likely be needed, probably within the range of 24 to 40 boreholes.

Piezometers and tensiometers would be installed strategically to monitor water levels and locate the capillary fringe between the tension-saturated and -unsaturated zones.

The alluvium soil stratum presumably would control the rate at which flushing water could be added because of its low permeability. This maximum rate is about 17 gpm (9 million gal/yr). An additional 8 gpm (about 4 million gal/yr) derives from natural infiltration from the surrounding canyon, yielding a total flushing water volume of about 25 gpm (13 million gal/yr) entering the Site. The estimated contaminated groundwater within the Site is 32 million gal. Therefore, flushing would take about 2.5 years to replace one pore volume of groundwater (32 million gal divided by 9 plus 4 million gal = 32/13 = 2.5 years).

The estimated 25 gpm of flushing water withdrawn from the Site would be treated in the mid-canyon pretreatment plant. Positive control of the hydrogeology at the Site must be secured to ensure that the flushing water added is captured. The implementation of a dewatering action before any soil flushing will allow determination of how well the extraction system functions onsite.

In-situ soil flushing could theoretically be applied to the Stringfellow Site; however, no previous in-situ flushing applications of this type or magnitude were identified, so the practical implementability of the technique remains unproven. The discussions herein are based upon theoretical concepts and idealized conditions. The estimates of volumes and cleanup times made above may differ significantly from what would be experienced should in-situ soil flushing actually be implemented.

The principal threat posed by the onsite source area stems from the presence of a large mass of water soluble contaminants potentially migrating offsite and contaminating downgradient groundwater. The use of onsite soil flushing could theoretically reduce onsite water-soluble contaminants to low concentration levels thereby minimizing the risk of recontaminating downstream areas that have been restored. Many flushes and long time periods would be required; yet during this time period, the risk to downgradient groundwater would be steadily declining as water soluble contaminants are removed by successive flushes of the onsite soil.

Upon completion of a successful in-situ soil flushing program, the contaminants mobile in water would be largely removed from the Site. Only the heavy metals and organics not mobile in water would remain, since they would be strongly adsorbed onto the soil. Raising of the groundwater pH by flushing would further reduce metals mobility. Basically, the Site would no longer present a serious threat to downgradient groundwater. Routine periodic monitoring would still be required, but only as a precaution; the only real restriction that would remain intact would involve preventing free public access to the onsite area.

4.4.3 Description of Downgradient Actions Incorporated in RA No. 4A

The downgradient actions in Zones 3 and 4 included in RA No. 4A are exactly the same as those described previously for RAs No. 2 and 3. However, the flow volume of Stream A proves an exception. In RA No. 2, the flow volume of the onsite leachate is estimated at 10 gpm from the outset. In RA No. 4, the initial year of dewatering generates an estimated flow volume of about 45 gpm. After dewatering is complete, maintenance of the dewatered condition yields 10 gpm of Stream A for about 2 years, until soil-gas extraction is completed. Following soil-gas extraction, the in-situ soil flushing program begins and continues for many years at an estimated Stream A flow rate of 25 gpm.

In the mid-canyon (Zone 2), RA No. 4A involves a more aggressive approach, involving additional extraction and reinjection wells in the area upgradient of the existing mid-canyon extraction well barrier. Treated Stream D and/or Stream C water could serve as reinjection water. The Stream B flow volume remains at an estimated 20 gpm, so the combined Stream A and B flow is about 45 gpm.

4.5 REMEDIAL ALTERNATIVE NO. 4B - ONSITE DEWATERING, EXTRACTION AND TREATMENT OF ONSITE LEACHATE, SOIL-GAS EXTRACTION, SELECTIVE SOIL EXCAVATION/TREATMENT, IN-SITU FLUSHING PLUS DOWNGRADIENT PLUME CLEANUP

4.5.1 General Description of Remedial Alternative No. 4B

This remedial alternative is similar to RA No. 4A, that was described previously in Section 4.4. The difference is that RA No. 4B interposes a selective excavation/treatment action after soil-gas extraction and before in-situ soil flushing. The selective excavation/treatment action involves the physical removal of identified "hot spot" onsite (Zone 1) areas where the level of contamination is much higher than the average for the onsite area. Physically removing a portion of the onsite contaminant mass prior to in-situ soil washing should result in the benefits of a slightly shorter flushing time and treatment of less contaminated Stream A flushing water.

As was the case with RA No. 4A, cleanup in Zone 2 is accelerated by installing reinjection wells within the mid-canyon and adding additional extraction wells upgradient from the existing mid-canyon extraction wells.

As is the case with all RAs (except No-Action), the lower-canyon (Zone 3) and community (Zone 4) groundwater plumes are cleaned up using extraction and reinjection wells, as was described in previous Sections 4.2.6 and 4.2.7. Also, additions to the drainage channels are included as an early implementation action.

4.5.2 Description of Onsite Actions Incorporated in this Remedial Alternative

The major onsite actions involved in RA No. 4B are as follows:

- Construct surface runoff drainage channels at the north and south ends of the Site. Construction of these channels is planned in 1989 as an early implementation action.

- Dewater the onsite area by lowering the water table to approximately the top of the bedrock. Surface extraction wells are considered the basic method and the drainage galley tunnel as a variation.
- The contaminated leachate (Stream A) extracted during initial dewatering (estimated at about 14 million gal) would be extracted during the first year of excavation with a maximum flow of about 45 gpm.
- Provide treatment in the existing mid-canyon treatment plant and disposal of the groundwater extracted during "steady state" conditions after initial dewatering is complete. The flow volume of this Stream A leachate is estimated at 10 gpm. This "steady state" condition will continue for only about 4 years while soil-gas extraction and selective excavation/treatment (see below) are being implemented.
- Implement in-situ soil-gas extraction in the onsite area, as previously described over an approximate 2-year period.
- Conduct sampling and analysis of the soil taken from the soil-gas extraction-well holes in order to identify areas of higher contamination (hot spots).
- When in-situ soil-gas extraction is complete, implement the excavation of areas of higher contamination (hot spots) providing such areas are identified. For feasibility study purposes the estimated volume of excavated soil (in-situ) is 300,000 cu yd.
- Contaminated soil will be stockpiled in a structure that protects it from wind and rain.
- Treat the excavated soil with incineration to destroy organic contaminants.
- Treat the incinerated soil with chemical stabilization to immobilize metal contaminants.
- Redispose the treated soil back into the excavation area.
- Implement in-situ soil flushing in the onsite area, if field tests prove favorable after soil-gas extraction and selective excavation/treatment.

Combining all of these onsite actions would provide flexibility during onsite cleanup operations to optimize each successive action sequentially depending upon the results of previous actions. During soil-gas extraction, the placing and sampling of nearly 1000 gas extraction holes onsite will provide an

excellent picture of onsite areal contaminant distribution. The extent of contaminant "hot spot" areas should be clearly defined. Logical decisions can be made regarding the feasibility, extent, and probable effectiveness of selective excavation as the next action. Finally, the wealth of data obtained from implementation of soil-gas extraction and selective excavation actions should allow accurate estimates regarding the type, quantity, and location of remaining residual contaminants. In-situ soil flushing could be optimally designed and managed to reduce the concentrations of remaining contaminants. The time period required for in-situ flushing to reduce onsite water soluble contaminants to acceptable levels should be shortened.

As a result of soil-gas extraction and selective excavation, much of the water soluble contaminant mass will have been removed prior to implementation of in-situ soil flushing. The contaminant concentrations in leachate will be less with proportionately lower treatment requirements.

All of the above onsite actions except selective excavation/treatment have been previously described in Section 4.3 (dewatering under RA No. 3) and Section 4.4 (soil-gas extraction and soil flushing under RA No. 4A). Therefore, only selective excavation/treatment is discussed in the following subsection.

4.5.2.1 Selective Soil Excavation/Treatment

Selective excavation (partial excavation) of selected site areas involves: (1) the delineation of onsite areas that have high soil contamination levels, (2) excavation of the digable soil, (3) temporary stockpiling of "clean" soil, (4) onsite incineration of the contaminated digable soil, (5) onsite chemical fixation of the incinerated soil, and (6) redisposal of the treated soil back into the excavation area. Digable soil is defined as material that can be excavated by conventional earth digging/moving equipment (e.g., scrapers, backhoes, clamshells, etc.) without the need to use blasting techniques typically used for rock.

During the Stringfellow Remedial Investigation (RI), areas were identified within the Site (north of the barrier wall) that exhibited significantly higher levels of organic halogen (SOX) contamination than the Site average. The present delineation of these zones of high contaminant content is limited by the extent of onsite sampling data. These zones do not have definitive boundaries across which contamination levels can be judged unacceptably high or acceptably low in terms of ultimate environmental or health risk. However, the presently available onsite data on soil contaminant levels do indicate the possibility of conducting selective excavation and treatment of onsite soil areas that are significantly more contaminated than the majority of the onsite soil mass.

The implementation of soil-gas extraction prior to selective excavation will provide a wealth of soil contamination data since soil samples can be analyzed from about 970 extraction well holes drilled in a grid pattern within the onsite area (Zone 1). This additional data would allow the precise identification and location of areas of higher levels of contamination.

For the purposes of this feasibility study, the best information available about hot spot location is from the Stringfellow RI. Seven high contamination areas were identified. The estimated total volume to be excavated from these seven high contamination areas (hot spots) is 300,000 cu yd in-situ volume.

Excavation is assumed to proceed at an average rate of approximately 750 cu yd/day (in-situ). Working days are assumed to average 200 days/year, 8 hr/day. At this rate the excavation of 300,000 cu yd would require approximately 2 years. Equipment used for excavation would be the contractor's decision and might include scrapers, draglines, backhoes, and/or front loaders. Depending upon the boundaries of the "hot spots" identified, the excavations will occur in several different areas within Zone 1 and be of various depths and sizes. For these reasons, it is estimated that the excavation rate will be 750 cu yd/day instead of the 1500 cu yd/day (in-situ) rate which has been assumed for the full-scale excavation described in the next section for RA No. 5.

For feasibility study purposes, it is assumed that raw material stockpiling must be provided for approximately 88,000 cu yd in-situ. Assuming a 25

percent swell factor, storage is required for up to 110,000 cu yd of material. Temporary buildings to enclose this stockpile would be 40 ft high and have a total floor area of about 110,000 ft^2. This is the same size storage as estimated for full-scale excavation in RA No. 5 in the Section 4.6.

Prior to the redisposal of the treated soil into the excavations it is envisioned that a liner would be installed on the floor and sides of the excavation. The primary function of the liner is to prevent the intrusion of potentially contaminated groundwater into the treated soil to avoid recontamination of the soil. The possibility of recontamination of the soil could only occur upon failure of the dewatering system.

4.5.2.2 Incineration of Excavated Contaminated Soil

Incineration treatability studies were performed on Stringfellow soil using a rotary kiln incinerator and an electric infrared incinerator. Incineration destroys hazardous organic compounds and converts them primarily to water and carbon dioxide along with trace emissions while the inorganic material remains almost in its original form, but it is dried.

Incineration treatability studies were performed on Stringfellow soil using a rotary kiln incinerator and an electric infrared incinerator. These treatability studies are included in the overall package of feasibility study documents. The quantity of soil excavated is estimated of 300,000 cu yd weighing 510,000 tons. The throughput rate during a 2-year period (400 days operating) would be 1275 tons/day or 53 tons/hr.

Incineration destroys hazardous organic compounds and converts them primarily to water and carbon dioxide along with trace emissions, while the inorganic material remains almost of its original form, but it is dried.

The by-products and residuals of incineration include the spent scrubbing liquor or spent adsorbent, and any of the offgases from the process. Acid-forming components present in the hazardous compounds are converted to HCl, SO_2, HF, etc. These acid gases are generally removed from the gas stream by an adsorbent or a scrubber. Oxides of nitrogen may be formed in the combustion process from organic or atmospheric nitrogen.

Gas emissions of principal organic hazardous constituents (POHCs), HCl, NO_x, and SO_x are expected to be low for both the rotary kiln and the electric infrared incinerator. Based on test data, the destruction and removal efficiency of POHCs ranges from 99.99 percent to more than 99.9999 percent. Therefore, only 0.01 percent to less than 0.0001 percent of the original hazardous material would be emitted. This meets the RCRA requirements for hazardous waste incinerators.

A scrubber will be required to control emissions of acid gases for both the rotary kiln and the infrared incinerator; removal of 99 percent of the HCl and 90 percent of the SO_2 can be expected. Emissions of NO_x of less than 125 ppm and particulates of less than 0.03 grains per standard cu ft (dry) are anticipated. A full-scale unit running at optimum conditions may significantly reduce these anticipated values.

At Stringfellow it is assumed that transportable incinerators would be brought onsite and the incineration would be done under contract to a firm responsible for the whole operation. Multiple units would be situated in an area of about 2.5 acres. This area would house preincineration processing equipment, scrubbers, and be set up for postincineration handling and stockpiling.

Auxiliary fuel, electric power, and water would be required in varying quantities, depending on the incineration technology selected. Water used in this purpose could be treated water from the downgradient plume.

4.5.2.3 Chemical Stabilization of Incinerator Ash Material

The stabilization/solidification treatment of hazardous waste refers to techniques that reduce the hazard potential of a waste by chemically converting the contaminants into less soluble, mobile or toxic forms, and then encapsulating the waste into a solid matrix of high structural integrity. After incineration, the contaminated soils at Stringfellow still contain elevated

levels of heavy metals. Stabilization/solidification of these soils is desirable to reduce acidity and metals mobility. The quantity of soil processed is estimated to be about 490,000 tons of dry soil during a two-year period (400 days operating). This provides a daily rate of 1225 tons/day.

Available stabilization/solidification systems are usually proprietary processes that consist of the addition of absorbent (and potential neutralizers or precipitants) and solidifying agents to a waste. The process can be modified to accommodate different kinds of wastes. Depending on the nature of the contaminants present, the ratio of additives can be tailored to achieve the optimum stabilized product.

The chemical reaction between soil and cement/sodium silicate takes place in a mixer designed to ensure that all waste is thoroughly contacted with the treatment materials.

A laboratory-scale study was conducted to determine the feasibility of implementing silicate-based stabilization/solidification treatment techniques at the Stringfellow Site and to determine effective pretreatment/formulation combinations. The results from this study showed that the most effective reduction in contaminant mobility was provided by sodium silicate fixation. The optimal pretreatment/formulation combination for the contaminants studied was incineration followed by treatment with 20 percent water, 20 percent cement, and 40 percent sodium silicate slurry (1 to 1 ratio of sodium silicate and water). These percentages are based on the weight of the incinerated soil. The addition of these formulation ingredients will result in a substantial increase in the volume and mass of soil/waste requiring disposal. It is estimated from laboratory results that the 300,000 cu yd of soil measured in-situ would have a final volume of about 400,000 to 450,000 cu yd. The final stabilized material is expected (based on the laboratory study results) to have a pH of 11 to 12. The stabilized matrix would be buried onsite in a large double-lined RCRA-type landfill.

This technology could be implemented at the Stringfellow Site; however, the material transport, storage, and handling requirements would be a major

challenge. The cement and sodium silicate requirements are nearly 100,000 tons each. The daily chemical deliveries of cement and sodium silicate would be about 500 tons, or about 25 large truckloads daily. The volume of truck traffic required to maintain this operation would warrant upgrading Pyrite Street. Furthermore, enclosed storage requirements for chemicals would be substantial.

Stabilization/solidification techniques have been successfully practiced for several years, and laboratory tests indicate that performance at Stringfellow should be satisfactory to immobilize metals.

The chemical formulations used in stabilization/solidification are usually proprietary. Experience in adjusting formulations to varying soil characteristics is necessary. For these reasons, the process at other locations has usually been done by private companies which provide all the necessary equipment, chemicals, labor, etc.

4.5.3 Description of Downgradient Actions Incorporated in this Remedial Alternative No. 4B

The downgradient actions in Zones 2, 3, and 4 included in this RA No. 4B are identical to the downgradient actions described in Section 4.4.3 for RA No. 4A with one exception. The maintenance dewatering of the Site, that results in a Stream A flow of about 10 gpm, would continue for 4 years instead of 2 years before in-situ soil flushing is initiated. The additional years are needed to maintain a dewatered condition during both soil-gas extraction (2 years) and selective soil excavation/treatment (2 years).

4.6 REMEDIAL ALTERNATIVE NO. 5 - ONSITE DEWATERING, EXTRACTION AND TREATMENT OF ONSITE LEACHATEEXCAVATION AND TREATMENT OF ALL THE ONSITE DIGABLE SOIL, PLUS DOWNGRADIENT PLUME MANAGEMENT

4.6.1 General Description of Remedial Alternative No. 5

This remedial alternative involves excavating the digable soil in the onsite (Zone 1) area and then treating the contaminated excavated soil with incineration and chemical stabilization. The treated soil is redisposed of onsite back into the excavation.

Prior to excavation the onsite area is dewatered (water table is lowered) and the dewatered condition is maintained throughout excavation and for a period thereafter. The onsite contamination extends into the decomposed granite (DG) and fractured bedrock well below the lower limits of the digable soil excavation. Therefore, a residual mass of contaminants is left onsite and it is necessary to continue extraction and treatment of this smaller soil volume for years after the excavation and treatment steps are completed.

Downgradient groundwater plume cleanup actions are essentially the same as previously described for RA Nos. 4A and 4B in Zones 2, 3, and 4.

4.6.2 Description of Onsite Actions Incorporated in this Remedial Alternative

The major onsite actions involved in RA No. 5 are as follows:

- Construct runoff drainage channels at the north and south ends of the Site. Construction of these channels is planned in 1989 as an early implementation action.
- Dewater the onsite area by lowering the water table. Surface extraction wells are considered the basic method and the drainage gallery tunnel as a variation.
- The contaminated leachate extracted during initial dewatering (estimated at about 14 million gal) over about a 1-year period would be treated as Stream A (maximum flow of 45 gpm) in the existing mid-canyon treatment plant.
- After initial dewatering is completed it will be necessary to keep the Site water table lowered (maintenance dewatering) during the estimated 5 years required for soil excavation and treatment. After soil excavation, treatment, and disposal is completed it will be necessary to continue to keep the site dewatered to prevent recontamination of the treated soil by contaminated groundwater located in the fractured bedrock and unexcavated DG beneath the Site. Maintenance dewatering will result in a small flow of contaminated leachate (Stream A) to be treated in the mid-canyon treatment plant.
- Excavate the digable contaminated material (alluvium/fill and some DG) located onsite and in the upper mid-canyon below the subterranean barrier dam. The excavation would proceed sequentially from north to south; only a portion of the Site would be an open excavation at any one time.

- **Stockpile the excavated soil in structures where they are protected from wind and rain. Segregate uncontaminated soil, soil with minimal organic contamination, and soil with high organic contamination from each other.**

- **Treat the contaminated soil. Soil with high organic and metal contamination would be incinerated and chemically stabilized. Soils with high metal contamination and minimal organic contamination would only be chemically stabilized.**

- **Redispose the treated material back into the onsite excavation area. A membrane and clay liner is installed in the bottom of the excavation below the redisposed soil.**

- Continue to operate the onsite dewatering system as a natural flushing system as long as necessary to clean up the remaining groundwater to a selected water quality objective.

4.6.2.1 Dewatering of the Onsite Area

Dewatering was covered in previous sections. Dewatering of the onsite area is estimated to require approximately 1 year after the dewatering system is in place. The estimated volume of extracted water in that first year is about 14 million gal, while the maximum flow rate is about 45 gpm. After the water table is lowered, the annual volume of groundwater that must be extracted to maintain the dewatered condition is estimated at about 4 to 5 million gal/yr, with a maximum flow rate of about 10 gpm.

In addition, during the excavation procedures the soil being handled drains retained contaminated water (even though it has been dewatered). Portable mud pumps are placed in the excavation to collect this contaminated water. In addition, water drains from the onsite storage stockpiles. These minor flows are combined with the Stream A dewatering flow for treatment at the mid-canyon treatment plant.

4.6.2.2 Excavation of Digable Material, Stockpiling, and Redisposal After Treatment

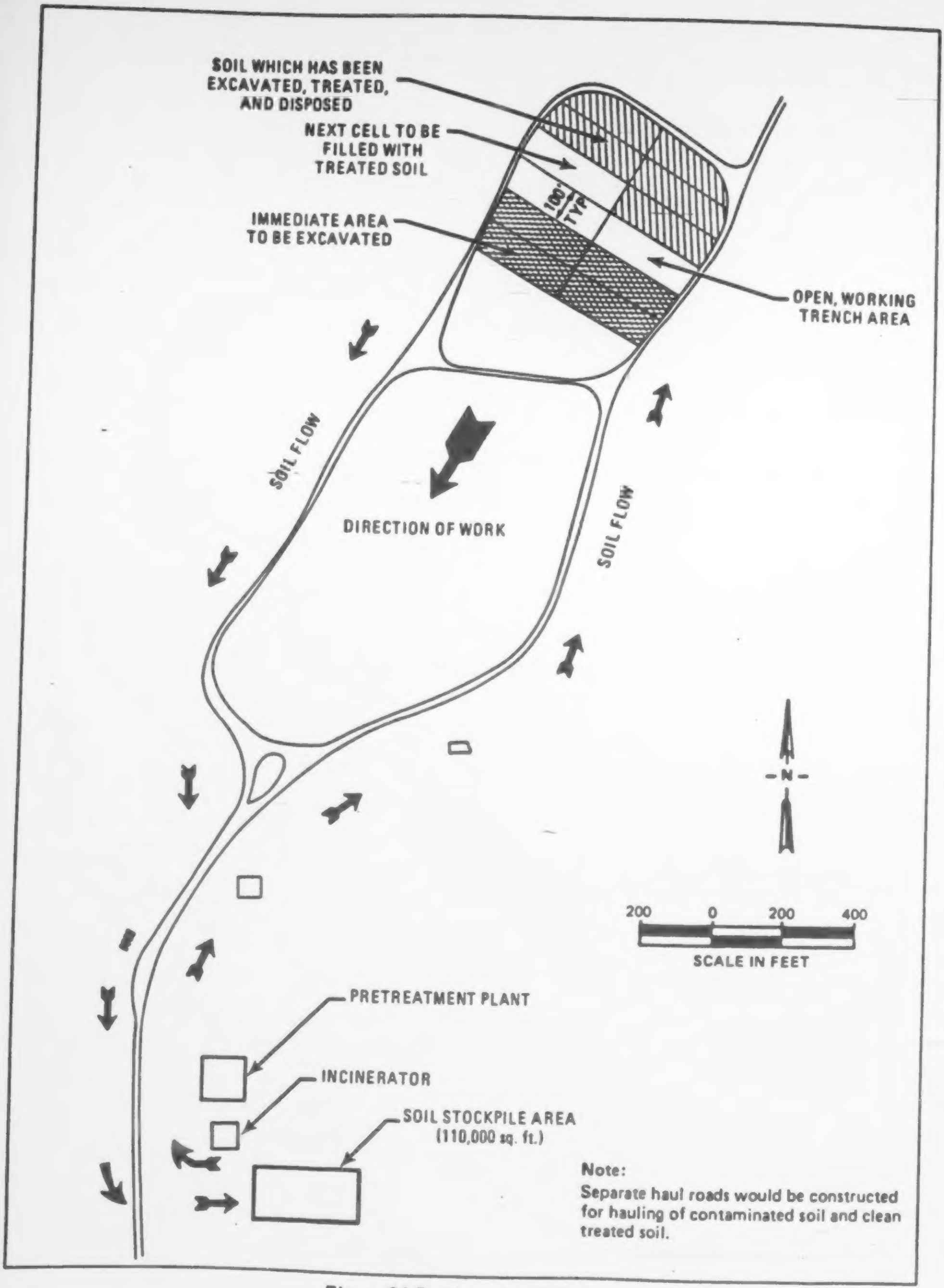
The estimate of total digable contaminated soil is 1.35 million cu yd of in-situ material, of which 920,000 cu yd are heavily contaminated. Upon excavation, the material can be expected to swell approximately 25 percent, creating about 1.7 million cu yd of loose soil.

Excavation is assumed to proceed at an average rate of approximately 1500 cu yd/day (in-situ). Working days are assumed to average 200 days/year, 8 hr/day. At this rate, the excavation of 1,35 million cu yd would require approximately 5 years. Equipment used for excavation would be the contractor's decision and might include scrapers, draglines, backhoes, and/or front loaders. The most feasible method is a continuous cycle of excavation, treatment, and redisposal with appropriate interim storage (stockpile) stages.

There are many possible excavation scenarios. One possible method (see Figure S4-5) would have excavation begin at the north end of the Site and remove all digable material within eastern and western Site boundaries. Two working faces would be established. The south face would involve the active excavation of contaminated soils, and the north face would be used for the active redisposal of treated soils. However, decisions concerning the exact slope necessary to provide adequate soil stability at the sides of the excavated area will be made during the design phase. A width of approximately 100 ft between the toe of the excavation slope and the toe of the redisposal slope would separate the two faces. This distance would provide sufficient working space for staged installation of a liner beneath the treated soil and allow for maneuvering of equipment. This 100-ft working zone would be maintained as the working faces of the excavation and redisposal continuously move southward.

The in-situ volume contained in the maximum excavation is approximately 88,000 cu yd. Assuming a 25 percent swell factor, storage for 110,000 cu yd of material must be made available at one time. The stockpile areas must be properly designed to protect the material from wind and precipitation. Prefabricated metal buildings to house this material would have a total floor area of 110,000 ft^2 and be 40 ft high. Prior to the redisposal of the treated soil, a liner will be installed on the floor of the previously excavated soil.

It should be emphasized that the excavation of over 1.35 million cu yd of hazardous material as envisioned above is a major undertaking. No excavation of similar magnitude was identified elsewhere. The approach described


SOIL WHICH HAS BEEN EXCAVATED, TREATED, AND DISPOSED
NEXT CELL TO BE FILLED WITH TREATED SOIL
100' TYP
IMMEDIATE AREA TO BE EXCAVATED
OPEN, WORKING TRENCH AREA
SOIL FLOW
DIRECTION OF WORK
SOIL FLOW
N
200 0 200 400
SCALE IN FEET
PRETREATMENT PLANT
INCINERATOR
SOIL STOCKPILE AREA (110,000 sq. ft.)

Note:
Separate haul roads would be constructed for hauling of contaminated soil and clean treated soil.

Figure S4-5. Operation Schematic

above is conceptual only and is intended to be representative in scope, rather than a blueprint of how the project would actually be accomplished.

4.6.2.3 Incineration of Excavated Material

Incineration of excavated material was previously summarized in Section 4.5.2 (RA No. 4B) where this technology is to be employed to thermally treat about 300,000 cu yd of soil excavated during selective (hot spot) excavation. In RA No. 5 it is estimated that about 115 million cu yd of contaminated excavated soil (920,000 cu yd in-situ) would be incinerated. In terms of weight the estimate is 1.6 million tons of material. For feasibility study purposes, it is assumed that the incineration would be done onsite under contract, with the contractor providing transportable incinerators and auxiliary equipment as well as all labor, supervision, testing, and support services. About a 5-year time period is estimated with the incinerators operating around the clock about 75 percent of the time.

4.6.2.4 Chemical Stabilization of Incinerator Ash Material

Previous Section 4.5.2.3 summarized the application of this process to about 300,000 cu yd of soil excavated in RA No. 4B under selected (hot spot) excavation. In addition, a separate volume contains the treatability study report for a laboratory scale test of stabilization processes used on Stringfellow soil. Study results showed that the most effective reduction in metal contaminant mobility was provided by sodium silicate fixation.

It is estimated that about 1.74 million tons of excavated, digable soil would be chemically stabilized. Based upon optimal laboratory results from chemically stabilizing incinerated Stringfellow soil, the following quantities of materials would be required for silicate fixation of 1.74 million tons of incinerated, dry Stringfellow soil:

- Water to prewet - 83 million gal (could use water extracted from the plume in Zone 4)
- Cement - 700 million lb
- Sodium silicate - 700 million lb

- **Water to mix with sodium silicate - 83 million gal (could use water extracted from the plume in Zone 4).**

Material transport, storage, and handling requirements would be a major challenge. The cement and sodium silicate requirements are over 350,000 tons each. Assuming that the process was operated for 1000 days over 5 years, the daily chemical deliveries would be about 740 tons, or about 40 large truckloads daily. The stretch of Pyrite Road that leads up to the Site would have to be improved. Enclosed storage requirements for chemicals would be substantial. In total, about 3 to 5 acres of space is estimated as required for this process.

If the process were used at the Stringfellow Site, the undertaking would be among the largest chemical stabilization/fixation projects ever attempted.

4.6.3 Description of Downgradient Actions Incorporated in this Remedial Alternative No. 5

The downgradient actions in Zones 2, 3, and 4 included in RA No. 5 are identical to the downgradient actions described in Section 4.4.3 for RA No. 4A with one exception. The maintenance dewatering of the Site, that results in a Stream A flow of about 10 gpm, would continue for about 60 years until the groundwater reaches cleanup objectives. In Zones 2, 3, and 4 an aggressive extraction and reinjection program is implemented to accelerate plume cleanup.

5.0 SUMMARY OF REMEDIAL ACTION ALTERNATIVES

INTRODUCTION

This chapter summarizes the five remedial action alternatives, which were analyzed in detail in Chapter 4, and compares their effectiveness, implementability and cost. The No-Action Alternative No. 1 is not included, except where applicable.

5.1 VARIATIONS (SUBDECISIONS) WITHIN REMEDIAL ALTERNATIVES

The five RAs, plus the No-Action Alternative, that were summarized in the previous Chapter 4 constitute the basic RAs for selection. However, as detailed in previous Section 4, in some cases several possible technologies were considered to accomplish the same objective(s) within an overall remedial alternative. The substitution of one technology for another is a "variation" in the RA and selecting between variations of an RA is termed a "subdecision".

Table S5-1 summarizes the eight technology variations described in Section 4 and the remedial alternatives within which each variation is a subdecision. The table also indicates which of the variations is the basic variation used in analyzing and preparing cost estimates for the remedial alternatives.

Referring again to Table S5-1, the following potential variations were rejected for the reasons shown.

- Variation No. 3 in Table S5-1. The use of air stripping instead of granular activated carbon (GAC) to treat Stream B was rejected because there was no significant technical or economic advantage to replacing the existing GAC technology with air stripping to remove organics from Stream B.
- Variation No. 4 in Table S5-1. The use of the PACT system instead of GAC to treat Streams A and B was rejected because there was no significant technical or economic advantage in using the PACT system instead of GAC.
- Variation No. 5 in Table S5-1. The disposal of treated Streams A and B to the industrial sewer via tanker trucks (as presently done), or the disposal of Streams A and B to solar evaporation

Table S5-1. A Summary of Technology Variations, and the Remedial Alternatives Within Which Each Variation is a Subdecision

Brief Description of the Technology Variations Evaluated	Selected* Basic Variation	RAs Within Which The Technology Is A Subdecision				
		2	3	4A	4B	5
1A. Onsite Dewatering Using Surface Extraction Wells, or	x		x	x	x	x
1B. Onsite Dewatering Using a Subsurface Drainage Tunnel			x	x	x	x
2A. Use of Air Stripping (With Emission Controls) Plus Reverse Osmosis to Treat Streams C and D, or	x	x	x	x	x	x
2B. Use of Granular Activated Carbon Plus Reverse Osmosis to Treat Streams C and D		x	x	x	x	x
3A. Use of Granular Activated Carbon to Treat Stream B, or	x	x	x	x	x	x
3B. Use of Air Stripping to Treat Stream B		x	x	x	x	x
4A. Use of Granular Activated Carbon to Treat Streams A and B, or	x	x	x	x	x	x
4B. Use of PACT System to Treat Streams A and B		x	x	x	x	x
5A. Disposal of Treated Stream A and B Effluent to the Industrial Sewer Via a Pipeline (In Conjunction with Stream C and D Sidestreams), or	x	x	x	x	x	x
5B. Disposal of Treated Stream A and B Effluent to the Industrial Sewer Via Tanker Trucks, or		x	x	x	x	x
5C. Disposal of Treated Stream A and Untreated Stream B to Solar Evaporation Ponds		x	x	x	x	x
6A. Disposal of Treated Streams C and D to Reinjection Wells to Accelerate Cleanup of the Groundwater Plume in the Community (Zone 4) and the Lower Canyon (Zone 3), or	x	x	x	x	x	x
6B. Disposal Of Untreated Streams C and D to the Industrial Sewer		x	x	x	x	x

Table S5-1. A Summary of Technology Variations, and the Remedial Alternatives Within Which Each Variation is a Subdecision (Continued)

Brief Description of the Technology Variations Evaluated	Selected* Basic Variation	RAs Within Which The Technology Is A Subdecision 2	3	4A	4B	5
7A. Disposal of Reverse Osmosis Concentrate Solution (A Sidestream from Stream C and D Treatment) to the Industrial Sewer Via Pipeline, or	x	x	x	x	x	x
7B. Disposal of Reverse Osmosis Concentrate Solution by (1) Further Concentration with Mechanical Evaporation, and (2) Disposal of Evaporation Slurry to Solar Evaporation Ponds		x	x	x	x	x
8A. Treatment of Excavated Contaminated Soil with Incineration and Chemical Stabilization, or	x				x	x
8B. Treatment of Excavated Contaminated Soil with Ex-situ Soil Washing, or					x	x
8C. Treatment of Excavated Contaminated Soil with Ex-situ Soil Washing for Volume Reduction Followed by Incineration and/or Chemical Stabilization					x	x

Note:

*Selected basic variation means that this variation is used in accessing the technical feasibility and estimating the costs of the remedial alternative.

ponds, were both judged inferior for cost reasons to the disposal of treated Streams A and B to the industrial sewer via pipeline. The analysis assumed that the pipeline to the industrial sewer would be built in any case to convey the reverse osmosis concentrate sidestream from treatment of Streams C and D.

- Variation No. 6 in Table S5-1. The disposal of treated Streams C and D to reinjection wells in order to accelerate cleanup of the groundwater plume was preferred over a variation where Streams C and D were disposed in total to the industrial sewer. The major reasons were (1) that reinjection significantly shortens the time required to clean up the contaminated groundwater plume, and (2) the present worth cost estimate is lower.
- Variation No. 7 in Table S5-1. Disposal of reverse osmosis concentrate solution to mechanical evaporation and solar evaporation ponds was rejected in favor of disposal to the industrial sewer for economic reasons. The decision would be reversed, however, if for some reason it was not possible to obtain additional permitted capacity in the industrial sewer, or it was not possible to construct a force main from the Stringfellow Site to the industrial sewer.

The above discussion briefly stated the reasons for selecting one variation over another for variations No. 3 through No. 7 shown in Table S5-1. At this stage of the process it is believed that there is relatively little controversy with regard to the above-listed subdecisions. Variations 1, 2, and 8 in Table S5-1, however, have been controversial and are summarized at greater length below.

Variation No. 1 in Table S5-1 is a subdecision regarding whether to dewater the onsite area (Zone 1) with surface extraction wells or with a subsurface drainage tunnel. Both technologies have strong advocates, and neither has clear-cut technical or economic superiority. The surface extraction-well variation was chosen over the subsurface drainage-tunnel variation primarily because of its much lower capital construction cost. If, for some reason, the surface extraction-well system did not perform adequately to lower the water table and keep it lowered, then relatively little capital expense would have been incurred, and the subsurface drainage tunnel could still be constructed. If, on the other hand, the subsurface drainage tunnel was constructed first and proved inadequate a large, irretrievable capital expense would have been incurred.

Variation No. 2 in Table S5-1 is a subdecision regarding whether to use air stripping (with emission controls) or GAC as a technology to remove organic contaminants during the treatment of extracted groundwater Streams C and D. Both technologies were judged technically feasible and the air-stripping technology was selected because it has lower capital and O&M cost. The major objection to the use of air stripping was that air stripping only removes the volatile organic contamination (e.g., TCE, chloroform, dichlorobenzene) but does not remove the nonvolatile organics (e.g., p-CBSA). Even though none of the nonvolatile organics identified in Streams C and D are listed as health hazards (e.g., priority pollutants), there was concern that an identified or unidentified nonvolatile organic compound might be an unrecognized hazard. This objection was overcome by the fact that the air-stripping treatment step would be followed by a reverse osmosis (RO) treatment step. During the RO treatability study, the recommended RO process membrane was shown to remove large-molecule, nonvolatile organics such as p-CBSA. Total organic carbon in the test water was reduced from about 16 mg/l to below 3 mg/l, the detectable limit for the analysis method used.

The other objection to air stripping was concern about uncontrolled emissions of volatile organics emanating from the stripping towers. This objection was overcome by the planned provision of vapor-phase activated carbon emission controls in series to provide redundant control.

Variation No. 8 in Table S5-1 is a subdecision regarding whether to use ex-situ soil washing as a technology to treat excavated contaminated soil in RA Nos. 4B and 5. Soil washing is a new technology which is being utilized at several sites in Holland and West Germany. The U.S. EPA has a continuing research program in soil washing, but no full-scale operating soil-washing facilities were identified at hazardous waste sites in the United States. The technology had been eliminated during the Stringfellow Feasibility Study Phase 1 screening process because it was judged unsuitable as a treatment method for a Stringfellow soil type which contains about 50 percent silt (below 60 microns particle size) and clay. The Dutch experience and EPA research indicate that soil washing is cost effective only for coarser, sandy soils. Recently, however, a West German firm has claimed success using soil washing to clean soil particles down to 15 microns in size. This German report spurred a recommendation by the Stringfellow Advisory Committee (SAC) and its technical consultant, Environ Co., that soil washing be reconsidered in the feasibility study. Time constraints precluded a thorough evaluation of soil washing, but a literature search was made and discussions were held with persons having knowledge about soil washing. It was concluded that incineration and chemical stabilization is preferable to soil washing alone or soil washing followed by incineration and/or chemical stabilization.

5.2 EFFECTIVENESS EVALUATION OF RAs

Effectiveness factors include short-term and long-term protectiveness and the ability to reduce the toxicity, mobility or volume of the contaminants of concern.

5.2.1 Short-Term Protectiveness

Short-term protectiveness evaluates the reduction of risks, compliance with ARARs, and protection of the community and workers during the construction and implementation of the remedial action.

5.2.1.1 Reduction of Existing Risks

By providing the community with an alternate drinking water supply, immediate health risks from contaminated groundwater consumption are being controlled. Risks associated with continued offsite contaminant migration are now largely controlled by the existing mid-canyon extraction well system. Construction of additional drainage system components, an early implementation action (EIA) scheduled for completion in 1989, will help prevent offsite migration of surface water contamination. A second EIA planned for 1989 is the lower canyon extraction well barrier just north of Hwy 60. This barrier is expected to largely eliminate continued migration of additional contaminated groundwater into the community area (Zone 4) south of Hwy 60. This existing mid-canyon extraction well barrier and future EIA activity are components of all five RAs.

In the community plume area (Zone 4) and lower canyon area (Zone 3) all RAs take an aggressive approach toward plume cleanup using extraction wells and reinjection wells. As the contaminants in the groundwater are gradually extracted from the plume, health risks are reduced.

5.2.1.2 Compliance with ARARs

None of the proposed RAs will attain short-term (less than 5 years) compliance with all contaminant-specific ARARS. Groundwater cleanup in the community will take an estimated 10 years, while other zones will require longer periods. Groundwater cleanup is defined as meeting the 10^{-6} health risk standard that is associated with an excess cancer risk of one case in a population of one million.

No location specific ARARs were identified for any of the RAs. In Section 5.2.2.3 compliance with long-term ARARs will be compared.

5.2.1.3 Protection of Community During Remedial Action

Protection of the community during implementation of the remedial action is measured by a number of factors. The first factor of concern is air quality. The public health risk analysis concerning inhalation exposure from compounds estimated to be released from implementation of RAs, found that none of the RAs would generate excess lifetime cancer health risks higher than 10^{-6} in the community. In fact, most risk factors are around 10^{-8}.

The risk analysis also looked at short-term noncarcinogenic risks (hazard indexes) from inhalation. In the community area all the calculations are well below 1, which is indicative of "no health risk". However, in the canyon RA No. 4A, RA No. 4B and RA No. 5 would produce results that are over 1. This indicates the possibility that in a worst-case situation, air contamination levels would be unhealthful for short periods just south of the onsite area in Pyrite Canyon. RA No. 4B and RA No. 5 both include excavation of onsite soil which carries an increased risk for release of fugitive VOC emissions. It will be necessary to monitor air quality levels in Pyrite Canyon during excavation procedures and have personnel protection equipment available.

In addition to air quality, the community, as well as involved government agencies, would be concerned about the possibility of accidental releases of contaminated groundwater into the environment. Several such scenarios were analyzed. It was concluded for all RAs that the possibility of a major release is very unlikely (e.g., from a pipeline or tank rupture). Further, if such a release were to happen, it would probably take place in remote Pyrite Canyon, some distance from the community, and would not create a health hazard. Nevertheless, it is important that facilities such as storage tanks be designed with enclosure berms, that O&M inspection and testing be rigorous, and finally, that adequate emergency response procedures be established to control accidental releases. The results of these analyses are presented in Summary Table S5-2.

5.2.1.4 Protection of Workers During Remedial Actions

Table S5-2 compares worker health and safety concerns associated with each RA. In comparing the alternatives in terms of worker health and safety risk factors, one can generalize that the more the remedial alternative involves disturbing and handling contaminated soils, the more hazardous is the RA. It can be concluded, therefore that RAs No. 2, 3, and 4A (using extraction wells as the dewatering technology) would cause the least problems from a health and safety standpoint. Since RA No. 5 and RA No. 4B both involve excavation of the Site, these alternatives would pose the greatest risk to workers. If the gallery drainage tunnel is built there will be inherent dangers related to the actual tunneling construction itself, but to a large extent, the degree of hazard will depend upon the extent of contaminated rock and water encountered.

5.2.1.5 Time Until Protection is Achieved

Theoretical calculations using analytical models were used (Appendix B and Chapter 4 of FS report) to make an estimation of the time period required for the contaminants in groundwater within each zone to reach certain chemical specific ARARs or target concentrations (e.g., TCE of 5 ppb, chloroform of 4.3 ppb, etc.). In addition, the time required to reach a carcinogenic health risk of 10^{-6} also was estimated. For feasibility study purposes, the time period needed for cleanup of various zones corresponds in Zone 1 to the time required to achieve concentrations corresponding to an excess lifetime cancer health risk of 10^{-6}. In Zones 2, 3, and 4 this corresponds to twice the time period estimated at the mid-point of the zone to achieve concentrations corresponding to an excess lifetime cancer health risk of 10^{-6}.

All the RAs except RA No. 1, No-Action, involve extraction and treatment of contaminated groundwater in all four zones. As described in Chapter 4 of the FS report, the cleanup of the Stringfellow Site would occur over relatively long estimated periods of time. See Table S5-2 for estimated time until groundwater cleanup is achieved by each RA in each zone.

5.2.2 Long-Term Protectiveness

The long-term protectiveness evaluates the magnitude of residual risk, the long-term reliability for providing continued protection and compliance with ARARs, and the prevention of future exposure to residuals contaminants.

5.2.2.1 Magnitude of Residual Risk

For contaminated groundwater, residual excess carcinogenic risk declines over time as the groundwater is cleaned up. For cleanup of the community (Zone 4) and the lower canyon (Zone 3), all five RAs are equal in reducing excess carcinogenic risk over time (Table S5-3).

The magnitude of risk in Zone 2 and Zone 1 (mid-canyon and onsite) declines at different rates according to the level of cleanup and technology employed. This is illustrated graphically in Figure S5-1 which shows the estimated lifetime excess carcinogenic risk remaining in the onsite area (Zone 1) versus time. RA No. 2 will gradually clean up the successive zones of the contaminated groundwater plume. Cleanup time ranges from 10 years in the community to over 400 years for the contaminated groundwater beneath the Site. During RA No. 2 and RA No. 3, the excess carcinogenic risk levels associated with groundwater consumption would decline to an acceptable level in the upper canyon (Zone 2) and at the same rate. Because of the addition of soil-flushing activity (see Table S5-4), risk reduction in Zone 2 during the implementation of RA No. 4A, RA No. 4B, and RA No. 5 would occur at a faster rate than RA No. 2 and RA No. 3. The most dramatic difference in changes in the magnitude of risk from residual contaminants over time occurs in the onsite area. Here RA

Table S5-3. Estimated Decline in Added Carcinogenic Risk from Lifetime Groundwater Consumption in Zone 3 and Zone 4 for All Proposed RAs

Estimated Residual Added Carcinogenic Risk from Lifetime Consumption of Water		
Number of Years	Zone 3	Zone 4
0	5×10^{-4}	4×10^{-5}
10	5×10^{-4}	1×10^{-6}
20	2×10^{-4}	NA
40	7×10^{-7}	NA

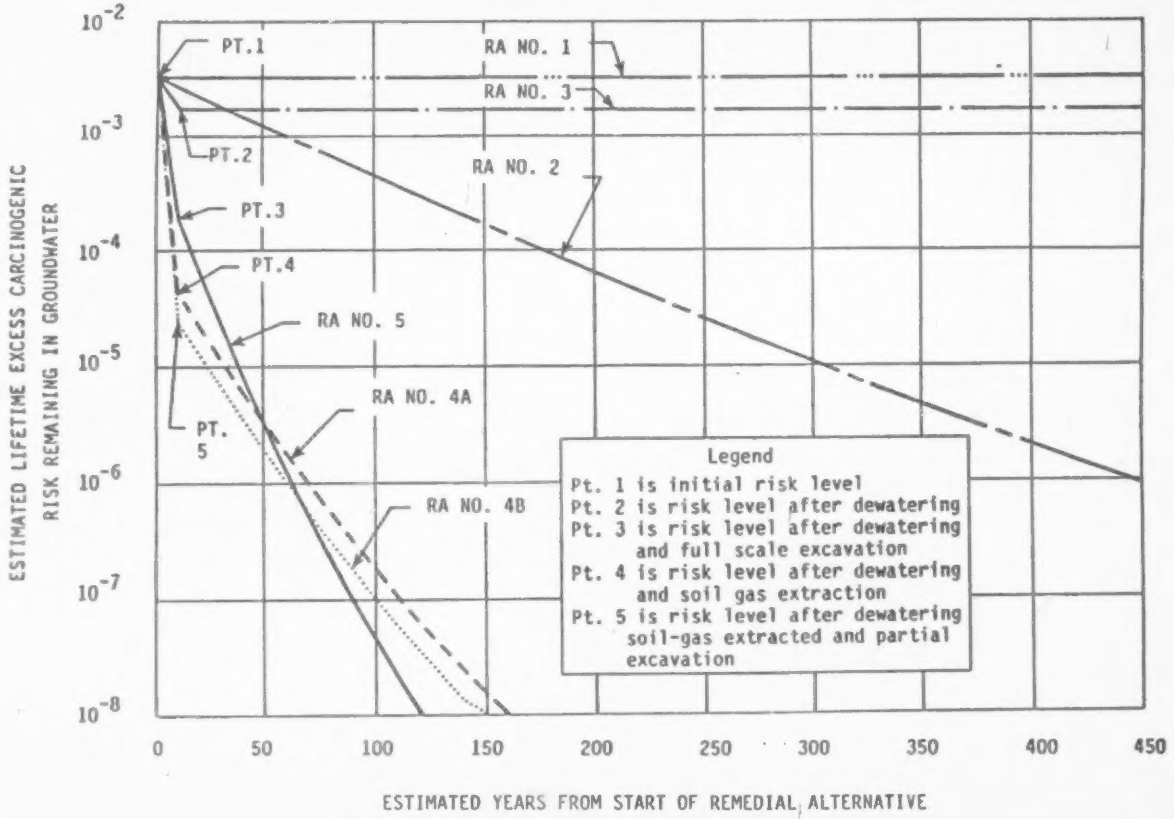


Figure 5-8. Estimated Lifetime Excess Carciongenic Remaining in Groundwater in Onsite Area (Zone 1) Versus Time

Table S5-4. Estimated Decline in Added Carcinogenic Risk from Lifetime Groundwater Consumption in Zone 2 for All RAs

	Estimated Residual Added Carcinogenic Risk from Lifetime Consumption of Water	
Number of Years	RA 2 and RA 3	RA 4A, RA 4B, RA 5
0	2×10^{-3}	2×10^{-3}
10	2×10^{-3}	2×10^{-3}
20	2×10^{-3}	2×10^{-3}
40	1×10^{-3}	4×10^{-5}
100	4×10^{-5}	NA
200	2×10^{-7}	NA

No. 2, as mentioned before, is estimated to require over 400 years to attain cleanup of residuals. RA No. 3 is a containment strategy that hydrologically isolates contaminants. Other alternatives, RA No. 4A, RA No. 4B, and RA No. 5 will hasten cleanup and are estimated to reduce risks to acceptable levels in about 60 to 70 years. Differences in risk reduction in the onsite area versus number of years each RA is employed can be seen in the Summary Table S5-2.

The residual risk from surface-water contamination due to contact with contaminated soil should be virtually eliminated by the construction of the multilayered cap and the improved flood control channels in RA No. 2 and RA No. 3. For RA No. 4A, RA No. 4B, and RA No. 5, the flood control channel will be improved, but installation of a new cap covering the entire Site is not included. Placement of a cap would not be consistent with the remedial actions of in-situ soil flushing and/or excavation. However, it is intended that early on during implementation of these RAs, any areas of surface contamination in the onsite area will be identified, cleaned up, or capped.

5.2.2.2 Long-Term Reliability

All components of RA No. 2 are proven technologies that can be quickly repaired or replaced. Groundwater movement is slow, so failure of extraction well systems to operate for a period of several weeks or even months will not cause a problem. Failure of the flood control channels and/or cap are unlikely, assuming the implementation of a sound O&M program.

The major reliability concern with RA No. 3 is the performance of either of the proposed dewatering systems. The gallery drainage tunnel has never been used to dewater a hazardous waste site and use of surface extraction wells to dewater fractured bedrock is also unproven. There is strong evidence that either method will achieve the desired result of lowering the onsite water table to near the bedrock surface.

Soil-gas extraction and onsite soil flushing, as proposed in RA No. 4A and RA No. 4B, are both unproven technologies for a large, heterogeneous site with low soil permeabilities such as Stringfellow. Limited experience elsewhere with smaller areas and more concentrated contaminants indicates that soil-gas extraction is a reliable means of reducing the concentrations of volatile organics in the unsaturated vadose zone. In-situ soil-flushing experience is even more limited, but the process has been used successfully in pilot and field testing.

Excavation/incineration components in RA No. 4B and RA No. 5 occur in less than 5 years and are not subject to long-term reliability analyses.

In summary, except for RA No. 2, the long-term reliability of some of the technologies employed in the remaining four RAs pose questions that will have to be answered with additional field tests prior to full-scale design and implementation.

5.2.2.3 Compliance with ARARs and TBCs

The driving indicator chemical in all zones is trichloroethylene (TCE), and it controls the length of time before compliance with groundwater quality ARARs are achieved. Estimated cleanup times to lower TCE levels to the MCL limit of 5 ppb for all zones are shown in Table S5-2. These estimated times are slightly lower than the estimated times to achieve a 10^{-6} excess health risk level. The health-based risk levels are based on the combined effect of all identified carcinogens, not just the ARAR for TCE.

All RAs achieve cleanup of groundwater to specific ARARs in Zones 3 and 4 in the same amount of time.

In Zone 2, RA No. 2 and RA No. 3 meet the TCE contaminant-specific ARAR in 126 years; however, because of implementation of soil flushing in RA No. 4A, RA No. 4B, and RA No. 5, the ARAR is achieved in 36 years.

Because of the implementation of onsite treatment actions, times to achieve the ARAR for TCE in onsite groundwater are about 40 years for RA No. 4A, RA No. 4B, and RA No. 5. RA No. 2 takes considerably longer. RA No. 3 will never achieve the ARAR standard in the onsite area. However, RA No. 3 is designed to immobilize the contaminants and a waiver may be obtained to allow adoption of this RA.

5.2.2.4 Prevention of Future Exposure to Residuals

In order to evaluate prevention of future human exposure to residual contaminants, it is necessary to consider the adequacy of residual containment systems, the proximity of contaminants to human populations via exposure pathways, and the remaining source strength/contaminant concentrations. This factor is related to long- term reliability, described earlier, and addresses the likelihood that exposure to residuals could occur, through either a technology failure or some other event.

Human exposure to residuals could occur primarily because the residual chemicals onsite (Zone 1) reached human receptors via an exposure pathway. The classical exposure pathways are ingestion of contaminated groundwater, ingestion of contaminated surface water, inhalation of contaminated air or particulates, ingestion of chemically tainted plant or animal food, and direct body contact. If the envisioned technical and administrative controls are implemented and properly maintained and operated, no significant contacts between humans and Stringfellow Site chemicals are likely to occur via any of these pathways after any RA implementation for the following reasons.

- Ingestion of contaminated groundwater - Currently, and in the future, alternative water supplies and institutional controls prevent use and ingestion of groundwater. The proposed containment/cleanup system, if maintained and kept operational, will over time, alleviate the danger associated with any public access to contaminated groundwater.
- Ingestion of contaminated surface water - If flood control drainage and cap system are maintained adequately, there should be virtually no risk of surface water contamination downgradient and possible subsequent human consumption. During soil excavation activities, there would be more risk for accidental contaminated runoff leaving the site in conjunction with a storm event. However, since Pyrite Creek (which conveys Stringfellow drainage) is not a drinking water supply source and with the significant dilution of contaminants associated with stormwater runoff that would occur, risks associated with human consumption of contaminated surface runoff are believed minimal.
- Inhalation of contaminated air or particulates - The Remedial Investigation (RI) report indicated that the Site in an undisturbed or capped condition produces negligible air contaminants. Modeling of contaminant concentrations from the various RAs indicates that none of them exceed acceptable risk levels in the community

area. A small risk of noncarcinogenic adverse effects exists with RA No. 3, RA No. 4A, RA No. 4B, and RA No. 5 in the Pyrite Canyon immediately below the Site but this can be mitigated by monitoring and personnel safety equipment.

- **Ingestion of chemically tainted plants or animal food - No crops are grown in Pyrite Canyon, however, sheep grazing occurs but not onsite. Therefore, no health risk would occur due to ingestion of tainted plant and/or animal food. Public exposure via body contact with onsite contaminants would not occur since a multilayered cap would be in place or surface contamination would be removed and the Site would be fenced and guarded.**

In summary, none of the RAs appear to pose a significant threat of future public exposure to residual chemicals. RA No. 3 poses a greater threat simply because the residual chemicals are largely left in place and because an unforeseen event has more time to occur. To a lesser extent, this is also true of RA No. 2, which takes a very long time to clean up the Site. However, under natural flushing the absolute quantity of water-soluble chemicals is estimated to decline dramatically in the first 100 years of operation.

5.2.2.5 Potential Need for Replacement

Each RA is evaluated from the perspective that there is a likelihood for RA replacement due to failure. The evaluation notes when such replacement might be needed and the risks associated with replacement. Failure is defined as failure of a major element of the RA to perform its intended function, and it does not refer to equipment or power failure or similar short-term correctable occurrences.

RA No. 2 uses proven technologies, and failure of their intended function is highly unlikely. No significant risks appear to be associated with such replacements. The technical elements of RA No. 2 are also common to the other four RAs that are proposed.

For RA No. 3, RA No. 4A, RA No. 4B, and RA No. 5, the dewatering with surface extraction wells could be replaced by a drainage tunnel if adequate Site dewatering is not attained. Relatively little capital expense will have been incurred and wasted. If the gallery drainage system is built first and does not function to dewater the Site, then dewatering of the Site would have to be abandoned, since surface extraction wells also could not accomplish dewatering. However, much more capital expense will have been incurred.

If the soil-gas extraction system or soil flushing system were to fail, it would be failure in performance only in that the contaminant removal would not be as effective as anticipated, and cleanup of Zone 1 would take longer than predicted.

5.3.2.6 Reduction of Toxicity, Mobility, or Volume

All of the proposed RAs are predicted to reduce all contaminants in the community area (Zone 4) and the lower canyon area (Zone 3) to drinking water levels during an estimated 40-year period.

For RA No. 2 natural flushing may gradually reduce water-soluble, mobile contaminants to drinking water levels in the mid-canyon area (Zone 2) and onsite area (Zone 1). Estimated time periods are very long due to the slow nature of natural flushing and the fact that drinking water standards are in the low ppb range for volatile organics (i.e., TCE). However, when looking at reduction of total mass of water mobile contaminants, it is clear that most are estimated to be removed in the first 60 years of natural flushing.

For RA No. 3 natural flushing may gradually reduce water mobile contaminants to drinking water levels in the mid-canyon area (Zone 2), but the estimated time period is about 160 years. In the onsite area (Zone 1), there is little reduction in the total contaminant mass after the initial slug of water-soluble contaminants is drained during the initial dewatering. Dewatering does however target the principle source of mobile, carcinogenic chemicals (i.e., the groundwater).

For RA No. 4A enhanced flushing is implemented to reduce water-soluble mobile contaminants to drinking water levels in the mid-canyon area (Zone 2) in an estimated 45 years. In the onsite area (Zone 1), it is predicted, based on theoretical calculations, that an excess health-based lifetime risk level of 10^{-6} may be reached in about 64 years.

For RA 4B enhanced flushing is implemented to reduce water-soluble mobile contaminants to drinking water levels in the mid-canyon area (Zone 2) in about 45 years. In the onsite area (Zone 1), it is predicted that, based on theoretical calculations, an excess health-based, lifetime risk level of 10^{-6} may be reached in about 59 years.

For RA 5, in the mid-canyon area (Zone 2) enhanced flushing is implemented to reduce water-soluble mobile contaminants to drinking water levels in about 45 years. In the onsite area (Zone 1), it is predicted that, based on theoretical calculations, an excess health-based lifetime risk of 10^{-6} may be reached in about 63 years.

Table S5-5 is a multipage table which summarizes the estimated total mass of various categories of contaminants and the estimated reduction in mass and mobility of onsite (Zone 1) contamination over time for all RAs. In Table S5-5 the RAs can be compared in effectiveness to remove total contaminant mass and individual categories of contaminants.

5.3 IMPLEMENTABILITY EVALUATION OF RAs

Comparison of implementability evaluation factors includes technical feasibility (short-term and long-term), administrative feasibility, and the availability of technologies and various support components for the remedial alternatives selected.

5.3.1 Short-Term Technical Feasibility

Short-term technical feasibility factors that will be compared for the various RAs include the ability to construct, the short-term reliability of the technologies, and compliance with action-specific ARARs.

5.3.1.1 Ability to Construct Technology

All of the technologies in RA No. 2 that are subsequently utilized in the other four RAs are standard technologies. Adequate space exists to conduct activities and construct facilities, and the necessary utilities are available. Thus, RA No. 2 has no identified constructability hurdles.

Table S5-5. A Summary of Estimated Contaminant Masses That Are Removed or Immobilized by Various Remedial Alternatives in the Onsite Area (Zone 1)

In order to define and quantify the reduction in mobility and mass of contaminants at the Stringfellow Site it is desirable to categorize these contaminants. The onsite mass of these categories was estimated in Appendix C and previous Table 4-2.

Category 1 - Organic contaminants that are essentially insoluble and nonvolatile. These immobile contaminants bond tightly to soil particles and are concentrated in the upper portions of the onsite area (Zone 1) below the cap and above the water table. Basically these contaminants have not moved from the soil they originally came in contact with. Typical of these immobile organic contaminants are PCB and DDT. The RAs are estimated to have the following effects on these contaminants.

- Original Quantity - 53,000 lb, all bound tightly to the soil (immobile)
- RA No. 2 has no effect on this category.
- RA No. 3 has no effect on this category.
- RA No. 4A has no effect on this category.
- RA No. 4B will remove and destroy that quantity of this category present in the soil that is excavated and incinerated during selective "hot spot" excavation. For feasibility study purposes this is estimated as 50 percent or 26,500 lb.
- RA No. 5 will remove and destroy that quantity of this category present in the soil that is excavated and incinerated. For feasibility study purposes this is estimated as 90 percent or 47,700 lb.

Category 2 - Metal contaminants that are soluble at a low pH (acid conditions) but precipitate into insoluble salts at higher pH (more neutral or alkaline conditions). At the Stringfellow Site these metal contaminants are located onsite (Zone 1) and in the upper (northern) portion of the mid-canyon (Zone 2). These metal contaminants are mobile only in acidic groundwater. As the acidic

Table S5-5. A Summary of Estimated Contaminant Masses That Are Removed or Immobilized by Various Remedial Alternatives in the Onsite Area (Zone 1) (Continued)

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leachate migrates out of the onsite area and the acidity is neutralized by the buffering capacity of the downgradient soil the metals are immobilized. Groundwater which is extracted from the mid-canyon extraction well barrier at the southern end of Zone 2 is at near neutral pH and contains negligible heavy metal contamination. Typical metal contaminants are cadmium, chromium, and nickel. The RAs are estimated to have the following effects on these contaminants:

- Original quantity of metals in solution (aqueous phase) = 1,000,000 lb.
- Original quantity of metals presently bound to the soil and immobilized = 21,000,000 lb. These soil bound metals are of no consequence since they could only be dissolved if the pH of the site groundwater decreased. All the RAs will increase the pH or have no effect.
- RA No. 2 will eventually largely remove metals in solution or cause them to become immobile due to increased pH. The time period may be several hundred years, though significant reductions are estimated to occur in the first 50 years. See curves in Appendix B.
- RA No. 3 removes about 43 percent, or 475,000 lb, of the metals in solution during the initial dewatering action in the first year. The remaining metals are left in the dewatered soil.
- RA No. 4A will eventually largely remove metals in solution or cause them to become immobile because of the increased pH. The time period is estimated as about 50 to 60 years, though significant reductions occur in the first 20 years.
- RA No. 4B is the same as RA 4A above except that an estimated 50 percent of the remaining dissolved metals are immobilized by chemical stabilization. This reduces the remaining mass in solution and reduces the time period for removal to 40 to 50 years, though significant reductions occur in the first 20 years.

Table S5-5. A Summary of Estimated Contaminant Masses That Are Removed or Immobilized by Various Remedial Alternatives in the Onsite Area (Zone 1) (Continued)

- RA No. 5 is estimated to remove or destroy by incineration about 1 million lbs (90 percent) of the soluble organics in the first 6 years. After 30 years only about 20,000 lb remain and after 60 years the remaining quantity is insignificant.

Category 4 - Organic contaminants that are both water soluble and volatile. These mobile contaminants are dissolved in the groundwater and move with it just as described above for Category 3. However, these contaminants are volatile and if exposed to air will move from the water phase to the air phase. There are degrees to which these organics are volatile. Typical of highly volatile, water soluble organics are TCE and chloroform. Both of these light molecule organics have migrated into Zone 4 south of Hwy 60. At the Stringfellow Site, TCE is being used as an indicator chemical to define the limits of the downgradient plume. The RAs are estimated to have the following effects on these contaminants:

- Original quantity = 79,000 lb, of which about 7000 lb is in solution.
- RA No. 2 slowly removes the volatile organics over a period of about 400 years, though a significant percentage is removed in the first hundred years.
- RA No. 3 removes about 3000 lb during the initial dewatering step. After this the volatile organics are left behind in the unsaturated soil.
- RA No. 4A largely removes volatile organics with soil-gas extraction. After 3 years it is estimated that only 3000 lb are left and after 30 years only 1000 lb.
- RA No. 4B is nearly the same as RA No. 4A, except that remaining quantities are about 1000 lb after 5 years and about 300 lb after 30 years.
- RA No. 5 involves dewatering, excavation, and incineration that are estimated to remove or destroy by incineration about 72,000 lbs of this category in the first 6 years. Not as good as RA No. 4A or RA No. 4B, because about 7000 lb remains. The remaining contaminants are removed in about 50 to 60 years.

Table S5-5. A Summary of Estimated Contaminant Masses That Are Removed or Immobilized by Various Remedial Alternatives in the Onsite Area (Zone 1) (Continued)

- RA No. 5 is estimated to remove or immobilize by chemical stabilization about 97 percent of the soluble metals during the first 6 years. The remaining 3 percent (30,000 lb) is removed during the next 30 years.

Category 3 - Organic contaminants that are water soluble with low volatility. These mobile contaminants are dissolved in the groundwater and move with it. By definition these contaminants are concentrated in the groundwater beneath the onsite area (Zone 1) and have migrated downgradient with the groundwater plume. If exposed to air these contaminants do not volatilize significantly. There are degrees to which various organic contaminants are soluble in water. Some are more soluble, and hence more mobile than others. Typical of a very water soluble nonvolatile organic is p-CBSA which has migrated as far south as Hwy 60 at the lower (southern) end of Zone 3. The RAs are estimated to have the following effects on this category of contaminants:

- Original quantity - 1.1 million lb. Of these 440,000 lb are estimated to be in solution.

- RA No. 2 will eventually largely remove organics in solution. The time period required might be several hundred years, though significant reductions are estimated to occur in the first 50 years.

- RA No. 3 removes about 43 percent of the mobile organics in solution, or 210,000 lb. The remaining nonvolatile, soluble organics are left in the dewatered soil.

- RA No. 4A will eventually remove organics in solution. The reduction is estimated to occur in the first 50-60 years with only about 100,000 lb left after 30 years and insignificant quantities after 60 years.

- RA No. 4B is nearly the same as RA No. 4A except that an estimated 50 percent of remaining organics are destroyed by excavation and incineration. This reduces the remaining mass of soluble organics and reduces the time period for removal to less than 50 years and only about 40,000 lb after 30 years.

Table S5-5. A Summary of Estimated Contaminant Masses That Are Removed or Immobilized by Various Remedial Alternatives in the Onsite Area (Zone 1) (Continued)

Category 5 - Inorganic contaminants that are soluble (no inorganic contaminants identified at Stringfellow are volatile to an appreciable extent). These inorganic contaminants are dissolved in the groundwater and move with it just as described above for Category 3. Some of these inorganic contaminants have migrated into Zone 4 south of Hwy 60. Typical of highly soluble inorganics are sulfates and nitrates. The RAs are estimated to have the following effects on these contaminants:

- The estimated total weight of this category onsite is 13 million lb, mostly sulfates. Of this amount about 4.6 million lb is in solution.
- RA No. 2 will eventually largely remove soluble inorganics in solution. The estimated time period is several hundred years though significant reductions occur in the first 50 years.
- RA No. 3 removes about 43 percent, or about 1.8 million lb, of the dissolved inorganics in the first year during the initial dewatering. The remaining inorganics are left in the unsaturated soil.
- RA No. 4A will eventually largely remove soluble inorganics. The time period is estimated at about 60 years, though 90 percent of the removal occurs during the first 30 years. After 30 years it is estimated that only about 1 million lbs is left.
- RA No. 4B is nearly the same as RA No. 4A above. Times are decreased slightly because some of the mass is immobilized during chemical stabilization of the soil excavated from the hot spots.
- RA No. 5 is estimated to remove or immobilize by chemical stabilization about 94 percent, or 11.3 million lb, of the inorganic contaminants present during the first 6 years. After 30 years only 180,000 lb is left, and after 60 years no significant amount remains.

The comparison of RA No. 3, RA No. 4, RA No. 4A, and RA No. 5 centers upon the various onsite technologies that are proposed.

Surface extraction wells utilize standard construction techniques, and any concerns regarding the technology are more with performance than with ability to construct. On the other hand, the gallery drainage tunnel presents substantial potential constructability problems, particularly with the unique worker safety problems that may hinder the ability to attract tunnel contractors to bid on the project. Though the tunnel boring machine (TBM) has a proven track record in constructing tunnel systems for major dewatering projects, this technology has never been employed beneath a hazardous waste site.

The soil flushing and soil-gas extraction technologies introduced in RA No. 4A and RA No. 4B both have uncertainties with regard to performance, but not construction. Because of the uncertainty in determining the number and location of onsite wells, a stepwise construction approach is recommended in which wells are installed in stages.

5.3.1.2 Short-Term Reliability

For all RAs, the technologies proposed for surface drainage structures, multilayered cap, and groundwater plume cleanup/management (i.e., extraction/reinjection wells, water treatment technologies) should meet the proposed performance standards. These component technologies are either now in use at Stringfellow or are proven in similar applications. RA No. 2, which is basically composed of the above-mentioned components, would meet proposed performance standards. Flexibility exists in operational modes to meet a wide range of treatment needs.

For RA No. 3, both of the dewatering technologies being considered, the surface extraction wells and the drainage gallery tunnel, have reliability concerns; however, it is believed, both technologies can meet the performance needs. Identified experience elsewhere is lacking for surface extraction wells that are used for permanent dewatering in fractured bedrock in the manner intended at Stringfellow and for drainage gallery tunnels installed beneath hazardous waste sites.

The ability of both the soil-gas extraction system and the soil flushing systems proposed for RA No. 4A and RA No. 4B to perform reliably is also unproven. These systems have been proven reliable in smaller applications and testing conducted elsewhere indicates that they would probably be successful at Stringfellow, especially in a phased approach. However, nowhere have these systems been used at a site as large and complex as the Stringfellow Site.

5.3.1.3 Compliance with Action-Specific ARARs

All RAs employ technologies that will be designed to meet the applicable action-specific ARARs. Those standards that are relevant and appropriate would also be taken into account when the technologies are designed. When entering the design phase for the selected RA, a review of the State and Federal laws listed in Chapter 2 of the FS report will have to be performed to determine which statutes are applicable, versus relevant and appropriate. These would then be incorporated into the design.

5.3.2 Long-Term Technical Feasibility

Factors involved in the long-term technical feasibility involve comparing each RA for its ability to undertake future actions, monitor effectiveness and perform O&M functions.

5.3.2.1 Ease of Undertaking Additional Remedial Action, If Necessary

All RAs are generally open to the possibility of additional remedial action, if necessary. In the downgradient zones, this could include such items as the installation of additional extraction wells and/or reinjection wells to improve or accelerate the cleanup of the groundwater plume.

This analysis is summarized in Table S5-2.

5.3.2.2 Ability to Monitor Effectiveness

For all RAs the progress of the groundwater cleanup in all zones can be monitored by means of monitoring well and extraction well sampling. In addition, water-level tables and groundwater flow patterns are measured using monitoring wells and instrumentation.

Individual technical components of each system can be monitored to ensure their proper working order, and on-line instrumentation or batch sampling could be used to ensure that the operation is not adversely affecting the environment.

Downgradient runoff will be monitored during storm events to determine the adequacy of surface-water controls. Air monitors will be installed and positioned to detect particulates or volatiles being emitted during onsite construction or treatment activities. This is especially critical for excavation/incineration activities (RAs No. 4B and RA No. 5). It is believed that all alternatives can be effectively monitored.

5.3.2.3 Ability to Perform O&M Functions

The key to O&M success is establishing a comprehensive program that possesses adequate resources to provide the administrative and operational infrastructure to perform O&M functions. O&M for all RAs at the Site is critical to ensure the remedial alternative selected will perform as designed. None of the technologies in any of the proposed RAs present insurmountable O&M problems. Standard operating procedures exist for wells, pumps, pipes, and water treatment technologies. The site multilayered cap and surface-water channels are easily maintained and require no unusual effort.

Certain newer, more innovative technologies such as the adit gallery, soil-gas extraction, and the soil flushing systems will require a shakedown period before operations and maintenance become "routine". Operating these systems is an "applied science" and requires specially trained and experienced personnel, who over time, can understand the operating nuances of these systems.

5.3.3 Administrative Feasibility

Administrative feasibility evaluates the ability to obtain approvals for each alternative from other agencies, as well as support from the community.

5.3.3.1 Ability to Obtain Approvals from Other Agencies

Permits are not legally required for CERCLA remedial activities performed onsite, but it is EPA policy to submit plans, designs, and reports to all involved local permitting agencies for their approval and recommendations. Offsite actions for the RAs proposed will require the necessary permits.

All RAs require permits for offsite disposal of hazardous wastes generated during performance of remedial actions, such as the sludge from treatment of Stream A at the mid-canyon pretreatment plant. This waste is hauled to a RCRA-permitted facility by a DHS-registered hazardous waste hauler. All RAs also require a Santa Ana Water Project Authority (SAWPA) permit to discharge treated groundwater to the SARI system. The additional flows generated by the implementation of downgradient plume cleanup will exceed the present permit volume limit, and a permit modification will be necessary.

The installation of extraction wells in the lower canyon and community requires a permit from the Riverside County Department of Health. Reinjection wells in the lower canyon and community require a permit from the Santa Ana RWQCB. Since most of the construction activity will occur in road/highway right-of-way, permits from the Riverside County Road Department will also be required.

All of the aforementioned permit requirements are common to all RAs proposed for the Stringfellow project.

For RA No. 3, RA No. 4A, RA No. 4B, and RA No. 5, if the gallery drainage tunnel is selected for dewatering, any uncontaminated water generated by the system might be surface discharged. Any such discharge would require a NPDES permit (or waiver) from the RWQCB.

Although the soil-gas extraction system (RA No. 4A and RA No. 4B) is onsite, plans and specifications for the system will be submitted to the South Coast Air Quality Management District (SCAQMC) for review and recommendations. The SCAQMD will serve a similar role in the implementation of the excavation and incineration of soil (RA No. 4B and RA No. 5).

5.3.3.2 Likelihood of Favorable Community Response

The community of Glen Avon has been regularly informed regarding the screening of remedial technologies and alternatives. The RAs that treat the onsite waste in a manner that permanently reduces the toxicity, mobility, and volume of the contamination would be favored. Table S5-2 discusses which RAs and individual technologies would likely be preferred by the community.

5.3.4 Availability

Availability focuses upon the availability of storage and disposal capacity for waste generated and the availability of equipment and personnel.

5.3.4.1 Availability of Treatment, Storage, and Disposal Services

All alternatives produce waste streams and are subject to the availability of RCRA-permitted facilities. The future of these types of facilities is uncertain, but for this analysis it is assumed that a usable offsite facility will be in existence for the life of the remedial action. In any case, all alternatives will be equally impacted should offsite disposal capacity diminish or sites no longer exist within a reasonable distance. Also RCRA land ban restrictions on disposal of hazardous wastes to land may impact disposal options.

5.3.4.2 Availability of Necessary Equipment and Specialists

Although various alternatives may require more resources than others for implementation and operation, the personnel and equipment are probably available for all five remedial alternatives to be implemented. All of the RAs require the application of skills that are readily available in the construction industry.

Obviously, more personnel and equipment are required for RA No. 4A, RA No. 4B, and RA No. 5 than RA No. 2 and RA No. 3. Short-term (less than 5 years) actions RA No. 4A, RA No. 4B, and RA No. 5 which include soil-gas extraction (RA No. 4A, RA No. 4B), flushing (RA No. 4A, RA No. 4B), and excavation, incineration, stabilization, and redisposal (RA No. 4B, RA No. 5) will require a larger resource base during this period. After soil-gas and excavation/redisposal are complete, RA No. 3 and RA No. 5 are similar in resource requirements, as are RA No. 4A and RA No. 4B, which also include the soil-flushing component. Obviously, RA No. 5 would require a tremendous expenditure of resources in equipment and labor. No comparable project has been identified at a hazardous waste site. It is assumed that sufficient resources somehow could be found and focused on the Stringfellow Site.

5.4 COST COMPARISONS OF RAs

Table S5-6 presents a summary of the estimated total capital and present worth costs for the basic RAs described in Chapter 4. There is essentially no cost associated with the No-Action alternative; it is shown for reference only. It is clear that the RAs become progressively more costly, a function of both capital and O&M expenditures. The large total present worth cost increases for RA No. 4B and RA No. 5, reflected in their capital costs are due to contaminated soil excavation, treatment, and disposal.

5.5 COMPARISON SUMMARY

Table S5-2 summarizes the important effectiveness and implementability categories which reflect the differences between RAs. Costs for each RA are also shown in this summary table.

Table S5-6. Estimated Capital Costs and Total Present Worth Costs for the Basic Remedial Action Alternatives

Remedial Alternative Number	Total Capital Cost* ($1000)	Total Present Worth** ($1000)		
		3%	7%	10%
1	--	--	--	--
2	36,050	213,408	133,972	111,426
3	38,406	277,641	164,881	134,759
4A	59,758	318,706	203,120	167,505
4B	237,561	490,272	378,328	343,237
5	583,847	802,748	709,673	680,165

*Total capital cost includes bid and scope contingencies, and permitting and legal, services during construction, and engineering design allowances. Scope contingencies used are as follows: RAs 2 and 3, 25%; RA 4A, 30%; RAs 4B and 5, 40%. These contingencies are based on the REM IV Cost Estimating Guide.

**Includes total capital cost. Three discount rates were used to calculate present worth for each alternative.

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Table S5-6 is in error. Refer to Table S5-2, Estimated Costs, for correct figures.